DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
JOSEPH A. HOLMES, DIRECTOR

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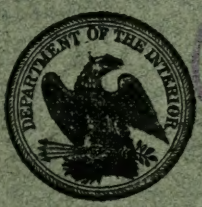
AT THE FUEL-TESTING PLANT, DENVER, COLO.
JULY 1, 1908, TO JUNE 30, 1909

BY

A. W. BELDEN, G. R. DELAMATER, J. W. GROVES
AND K. M. WAY



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By A. W. Belden, G. R. Delamater, J. W. Groves, and K. M. Way.

INTRODUCTION.

By A. W. Belden.

This bulletin deals with washing and coking tests of coal made at the Government fuel-testing plant in Denver, Colo., between July 1, 1908, and June 30, 1909. The tests formed part of the investigation of mineral fuels carried on by the United States Geological Survey under the authority conferred by acts of Congress, and were a continuation of the work started at St. Louis, Mo., during the Louisiana Purchase Exposition. They were made at Denver because of the railroad facilities and central location of that city with respect to coal fields from which little or no coal had been received at the St. Louis plant. The general purpose of the investigations was (1) to determine the possibility of improving the quality of various coals by washing, so as to make them available for the production of coke, and (2) to determine the feasibility of making coke in beehive ovens from these coals. The results of the tests made at Denver are published by the Bureau of Mines because the law creating the bureau transferred to it the testing of fuels as carried on by the United States Geological Survey.

The Denver plant began operations November 19, 1907. Between that date and March 21, 1908, when work was temporarily suspended, 34 washing tests and 52 coking tests were made on 14 carload samples of coal, representing deposits in Colorado, Montana, Utah, and New Mexico. The results of these tests have been described in a previous bulletin.[a]

After the completion of this first series of tests it was decided, because coals representing deposits in a number of important fields had not been received for test, to continue the work long enough to gather the desired information regarding the additional coals and to compare the results of washing and coking tests with those on coals previously tested.

[a] Belden, A. W., Delamater, G. R., and Groves, J. W., Washing and coking tests of coal at the fuel-testing plant, Denver, Colo., July 1, 1907, to June 30, 1908: Bull. U. S. Geol. Survey No. 368, 1909, 54 pp.

The plant resumed operations August 21, 1908, and was operated continuously until January 2, 1909. During this period 20 cars of coal were received from 19 places, representing six States and one Territory, as follows: Colorado, 11 cars; Washington, 3 cars; Illinois, 2 cars; Kansas, 1 car; Montana, 1 car; New Mexico, 1 car; and Wyoming, 1 car. On these 20 samples the washery section made 49 tests and the coking section 69 tests. The chemical laboratory made 532 analyses, entailing 3,253 different determinations.

The washery tests were conducted in practically the same manner as those described in Bulletin 368, except for some minor changes in and additions to the equipment, fully described under the discussion of the tests on succeeding pages.

The coking tests were carried on in precisely the same way as was outlined in Bulletin 368. Of the 22 samples tested, all but five produced good coke in the beehive oven by proper treatment. The yield of coke from a number of coals was materially greater than that obtained by concerns coking the same coals in a commercial way. For one coal this difference was over 4 per cent. Such an increase is of much greater importance than it might seem to be at first thought. Consider, for instance, a plant producing 20,000 tons of coke a month. If the yield is 60 per cent of the coal charged to the oven when it might be made 64 per cent, the net yearly loss, with coke selling at $3.50 per ton, f. o. b. cars at ovens, would amount to $55,986.

FIELD WORK.

By J. W. Groves and K. M. Way.

TEST REQUIREMENTS.

The stipulations under which coal was submitted for test and the methods of inspecting the coal and taking the mine samples were the same as for the previous tests at Denver, and as for the years 1905 and 1906, when the plant was at St. Louis, Mo. These stipulations were as follows:

1. The coal must be furnished to the testing plant free of cost to the Government.
2. The coal must be loaded under the supervision of one of the inspectors employed for that purpose, who shall at the same time be allowed to visit the working places in the mine to secure samples for analysis.
3. When it is possible to do so, the coal should be loaded in box cars and shipped under seal. Lignites must always be shipped in this way.
4. Where the market requires screened coal, this grade will be accepted for tests. The selection of coal is always to be under the direct control of the representative of the testing plant.
5. Where one of the problems involved is the better utilization of slack coal, a carload of slack may be accepted for testing purposes.

6. As soon as possible after the tests are completed, a brief statement of the results will be furnished to parties supplying the coal, for their information, but this must not be made public until the results are made public by the Geological Survey.

7. Everyone interested in any particular test or in the general operation of the plant is invited to be present at any time, but the official record of the tests will not be given out except as indicated in the preceding paragraph.

8. In view of the probability of receiving applications from two or more operators working the same bed of coal in the same locality, the right is reserved to accept but one such application, in order that unprofitable duplication of results may be avoided.

INSPECTION PROCEDURE.

In collecting samples the inspector made certain that the coal loaded for testing represented the average product of the mine, and, if screened coal was to be sent, that the size selected was commercially available and adapted to the purpose for which it was to be tested. Therefore, he examined the screens and observed the method generally employed in separating slate and other impurities from the coal while it was being loaded in the railroad car. He then entered the mine and carefully noted the character of the bed, the method of mining, and the care taken by the miners to separate the shale partings and sulphur balls from the coal while loading mine cars. While the sample was being loaded into the railroad car the inspector stood inside the tipple and permitted the slate pickers to discard only such material as was thrown off in the usual practice and as was consistent with the customary speed of loading. The material thrown out was afterwards examined by the inspector to determine why it was considered detrimental to the fuel value of the coal.

MINE SAMPLING.

In mine sampling the object of the inspector was to procure a sample that would, as nearly as possible, represent run-of-mine coal. He first made a careful study of the coal throughout the mine and observed what parts of the coal bed were discarded by the miner. In an ordinary mine two or more places where the coal was of average development were then selected. These places were usually at widely separated points in the part of the mine from which most of the coal was being shipped. The selected face was cleaned for 5 feet or so, and insecure pieces of the roof were taken down. The sampler then spread a waterproof blanket close up to the face and made a perpendicular cut from floor to roof, including in the sample everything but the parts of the bed discarded by the miner, and cutting not less than 5 pounds of coal per foot in height—that is, a sample weighing not less than 30 pounds from a 6-foot seam. Great care was exercised in cutting included shale or other partings the full

width and depth of the groove in order to preserve the proper proportion of coal and extraneous matter. A detailed record was made of the section of the bed from top to bottom, every perceptible parting and variation being noted. The parts of the bed not included in the sample were clearly shown in this record.

The cuttings were at once weighed and then sifted through a screen with a half-inch mesh. The remaining lumps were broken up on a portable bucking board, and this screening and breaking was continued until the entire sample passed through the screen.

The sample was then mixed by two men grasping the corners of the blanket and rolling the sample diagonally by raising one corner of the blanket at a time. When the larger pieces were seen to be evenly distributed throughout the mass, the sample was quartered, two opposite quarters discarded, and the remainder mixed as before. If the sample was still too bulky to be conveniently handled it was again mixed and quartered.

The remaining material was spread in a circular mass about 2 inches deep on the blanket, and a small trowel was used to fill a sample can with alternate sections of the sample taken from the circumference to the center of the mass around the entire circle. The can was closed and hermetically sealed with electrical insulating tape and the weight noted. This weight showed what proportion of the original sample was sent to the laboratory.

The entire process of sampling was carried on as rapidly as possible. The maximum time for cutting and preparing a large sample was about one hour. Although it is known that rapid changes take place in the moisture content of some coals, it is reasonable to assume that where the sampling is quickly done in the atmosphere to which the native coal is exposed there is probably only a slight gain or loss of moisture while the sample is being broken up and quartered.

DESIGNATION OF SAMPLES.

The samples of coal sent to the Denver testing plant are designated in this bulletin Denver No. 15, Denver No. 16, and so on, consecutively, continuing the series of numbers used in Bulletin 368, "Denver" being placed before each number to distinguish the samples from those sent to St. Louis, Mo.; Norfolk, Va.; and Pittsburg, Pa. The samples are designated by these numbers throughout the tests and in the published results.

In like manner the laboratory numbers of the analyses are followed by the letter D to show that the analyses were made at Denver. For Denver Nos. 29 and 30 analyses of mine samples previously taken and analyzed at Pittsburg are used.

SAMPLES TESTED AT DENVER.

The following is a complete list of the samples tested at Denver from August 21, 1908, to January 2, 1909:

List of coals tested at Denver, Colo.

[All samples inspected by either J. W. Groves or K. M. Way.]

Designation of sample.	Kind of fuel.	Name of bed.	Locality.	Railroad.	Days exposed to weather.
Denver No.—					
15	Bituminous, run of mine.	No. 6	Sesser, Franklin County, Ill.	Chicago, Burlington and Quincy.	13
16	do	Sopris	Sopris, Las Animas County, Colo.	Colorado Southern	13
17	do	Walsen	Bowen, Las Animas County, Colo.	do	9
18	do	Primero	Primero, Las Animas County, Colo.	Colorado and Wyoming.	17
19	do	Nos. 4, 5	Taylor, King County, Wash.	Columbia and Puget Sound.	23
20	do	No. 3	Carbonado, Pierce County, Wash.	Northern Pacific	54
21	Bituminous, run of mine, ¾-inch screenings.	Roslyn	3 miles west of Roslyn, Kittitas County, Wash.	do	32
22	Bituminous, run of mine.	(?)	Lombard, Broadwater County, Mont.	do	19
23	do	Cherokee	3 miles west of Frontenac, Crawford County, Kans.	Atchison, Topeka and Santa Fe.	21
24	Refuse		Starkville, Las Animas County, Colo.	do	12
25	Bituminous, 1-inch screenings.	Cameron	1½ miles southwest of Rugby, Las Animas County, Colo.	Colorado and Southern.	14
26	Subbituminous, run of mine.	Lower seam.	Lafayette, Boulder County, Colo.	Colorado and Southern.	13
27	Bituminous, run of mine.	Berwind	1 mile west of Berwind, Las Animas County, Colo.	Colorado and Southern.	25
28	Bituminous, 4-inch, run of mine.	(?)	Cameo, Mesa County, Colo.	Denver and Rio Grande and Colorado Midland.	10
29	Bituminous, run of mine.	Upper	Coal Basin, Pitkin County, Colo.	Crystal River	20
30	do	Lower	do	do	16
31	do	Carthage	Carthage, Socorro County, N. Mex.	New Mexico Midland	27
32	do	Yampa	Oak Creek, Routt County, Colo.	Denver, Northwestern and Pacific.	12
33	do	No. 7	Sweetwater, Sweetwater County, Wyo.	Union Pacific	13

DETAILED DESCRIPTIONS OF SAMPLES.

Denver No. 15.

Bituminous coal from No. 6 bed at Sesser, Franklin County, Ill., on the Chicago, Burlington and Quincy Railroad, was designated Denver No. 15.

One sample shipped from this place consisted of 44 tons of run-of-mine coal, which was used in making washing tests 232, 233, 234, and 235, and coking tests 247, 248, 249, 250, and 251.

A second sample from this place, which consisted of 33 tons of 1½-inch screenings and was designated Denver No. 15–B, was used in making washing tests 236, 238, 239, and 240, and coking tests 252, 254, 256, and 258.

Two mine samples were taken for chemical analysis; sample 477–D was taken 980 feet northwest of the shaft, where the coal measured as shown in section A; sample 478–D was taken 1,220 feet north of the shaft, where the coal measured as shown in section B.

Section A (sample 477–D).

	Ft.	in.
Coal		7
Rash		1
Coal	3	9
Shale [a]		1½
Coal		8
Blue band [a]		1½
Coal	1	7
	6	11

Section B (sample 478–D).

	Ft.	in.
Coal	3	10
Shale		¾
Coal		8
Blue band [a]		1¼
Coal	1	10
	6	6

Chemical analyses of Denver No. 15 coal.

	Mine samples.						Car samples.					
	477–D.			478–D.			486–D.			495–D.		
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	1.20	.....	.....	1.10	.....	.....	3.60	.....	.....	3.30	.....	.....
Prox. Moisture	8.05	9.15	.....	7.57	8.59	.....	4.69	8.12	.....	5.49	8.61	.....
Prox. Volatile matter	35.40	34.98	38.50	32.51	32.15	35.17	35.76	34.46	37.51	34.32	33.19	36.30
Prox. Fixed carbon	47.85	47.27	52.03	51.60	51.03	55.83	50.60	48.79	53.10	48.42	46.82	51.22
Prox. Ash	8.70	8.60	9.47	8.32	8.23	9.00	8.95	8.63	9.39	11.77	11.38	12.48
Ult. Sulphur	1.00	.99	1.09	1.30	1.29	1.41	1.17	1.13	1.23	.98	.95	1.04
Ult. Hydrogen	.....	.....	.....	.....	.....	.....	.....	5.26	4.73	.....	5.15	4.58
Ult. Carbon	.....	.....	.....	.....	.....	.....	.....	66.44	72.31	.....	64.93	71.05
Ult. Nitrogen	.....	.....	.....	.....	.....	.....	.....	1.33	1.45	.....	1.36	1.49
Ult. Oxygen	.....	.....	.....	.....	.....	.....	.....	17.21	10.89	.....	16.23	9.39
Calorific value: Determined— Calories	.....	.....	.....	6,805	6,730	7,363	6,952	6,702	7,295	6,656	6,436	7,042
B. t. u.	.....	.....	.....	.....	12,114	13,253	12,514	12,064	13,131	11,981	11,585	12,676
Calculated from ultimate analysis— Calories	.....	.....	.....	.....	.....	.....	.....	6,465	7,036	.....	6,343	6,941
B. t. u.	.....	.....	.....	.....	.....	.....	.....	11,637	12,665	.....	11,417	12,493

Denver No. 16.

Bituminous coal from the Sopris or "Cameron" bed at Sopris, Las Animas County, Colo., on the Colorado and Southern Railway, was designated Denver No. 16.

[a] Not included in sample.

One sample shipped from this place consisted of 50 tons of run-of-mine coal and was used in making washing tests 242, 247, and 249, and coking tests 259, 260, 266, 268, and 271.

Two mine samples were taken for chemical analysis. Sample 479–D was taken 7,000 feet southwest of the slope, where the coal measured as shown in section A; sample 485–D was taken 8,800 feet southeast of the slope, where the coal measured as shown in section B.

Section A (sample 479–D).

	Ft.	in.
Coal	3	11

Section B (sample 485–D).

	Ft.	in.
Bone coal [a]		9½
Coal	1	2
Hard coal (good)		6
Coal		2
Bone coal [a]		1½
Coal	1	8
	4	5

Chemical analyses of Denver No. 16 coal.

	Mine samples.						Car sample (536–D).		
	479–D.			485–D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	2.10			1.40			1.10		
Prox. Moisture	.31	2.40		.51	1.90		1.26	2.35	
Prox. Volatile matter	29.92	29.29	30.01	31.23	30.79	31.39	31.03	30.69	31.43
Prox. Fixed carbon	57.05	55.86	57.25	57.23	56.43	57.52	53.39	52.80	54.07
Prox. Ash	12.72	12.45	12.74	11.03	10.88	11.09	14.32	14.16	14.50
Ult. Sulphur	.90	.88	.90	.70	.69	.70	.65	.64	.66
Ult. Hydrogen								4.63	4.48
Ult. Carbon								71.12	72.83
Ult. Nitrogen								1.04	1.07
Ult. Oxygen								8.41	6.46
Calorific value: Determined— Calories				7,610	7,503	7,648	7,183	7,104	7,275
Calorific value: Determined— B. t. u					13,505	13,766	12,929	12,787	13,095
Calculated from ultimate analysis— Calories								6,995	7,163
Calculated from ultimate analysis— B. t. u								12,591	12,894

Denver No. 17.

Bituminous coal from the Walsen bed of coal at Bowen, Colo., on the Colorado and Southern Railway, was designated Denver No. 17.

One sample shipped from the bed consisted of 33 tons of run-of-mine coal and was used in making washing tests 237, 241, and 244, and coking tests 253, 255, 257, and 261.

Two mine samples were taken for chemical analysis. Sample 480–D was taken 2,000 feet north of the drift opening, where the coal

[a] Not included in sample.

measured as shown in section A; sample 481–D was taken 2,600 feet northwest of the drift opening, where the coal was measured as shown in section B.

Section A (sample 480–D.)

	Ft.	in.
Coal	3	
Bone coal [a]		3
Coal	1	10
	5	1

Section B (sample 481–D).

	Ft.	in.
Coal		11
Bone coal [a]		6
Coal	2	6
Bone coal [a]		2
Coal		11
	5	0

Chemical analyses of Denver No. 17 coal.

	Mine samples. 480–D. Air dried.	480–D. As received.	480–D. Dry coal.	481–D. Air dried.	481–D. As received.	481–D. Dry coal.	Car sample (494–D). Air dried.	Car sample (494–D). As received.	Car sample (494–D). Dry coal.
Air-drying loss	1.70			2.20			0.50		
Prox. Moisture	.78	2.47		.79	2.97		1.41	1.90	
Prox. Volatile matter	34.24	33.66	34.51	33.23	32.50	33.50	31.52	31.36	31.96
Prox. Fixed carbon	53.91	52.99	54.33	51.69	50.55	52.09	49.16	48.92	49.88
Prox. Ash	11.07	10.88	11.16	14.29	13.98	14.41	17.91	17.82	18.16
Ult. Sulphur	.83	.82	.84	.66	.65	.67	.68	.68	.69
Ult. Hydrogen								4.63	4.49
Ult. Carbon								67.82	69.13
Ult. Nitrogen								1.18	1.20
Ult. Oxygen								7.87	6.33
Calorific value: Determined— Calories				7,092	6,936	7,148	6,737	6,703	6,833
Calorific value: Determined— B. t. u.					12,485	12,866	12,127	12,065	12,299
Calculated from ultimate analysis— Calories								6,753	6,884
Calculated from ultimate analysis— B. t. u.								12,155	12,391

Denver No. 18.

Bituminous coal from Primero bed at Primero, Las Animas County, Colo., on the Colorado and Wyoming Railroad, was designated Denver No. 18.

One sample shipped from the bed consisted of 40 tons of run-of-mine coal and was used in making washing tests 243, 245, 246, and 248, and coking tests 262, 263, 264, 265, and 267.

Two mine samples were taken for chemical analysis. Sample 483–D was taken 4,200 feet west of the drift opening, where the coal measured as shown in section A; sample 484–D was taken 3,000 feet northwest of the drift opening, where the coal measured as shown in section B.

[a] Not included in sample.

Section A (sample 483–D).

	Ft.	in.
Coal [a]		5½
Bone coal [a]		1½
Coal	1	4
Bone coal [a]		1½
Coal	1	2
Bone coal		1
Coal	4	1
	7	4½

Section B (sample 484–D).

	Ft.	in.
Bone coal [a]		7
Coal		6
Bone coal [a]		1½
Coal		10
Bone coal		½
Coal	5	1
	7	2

Chemical analyses of Denver No. 18 coal.

	Mine samples.						Car sample (537–D).		
	483–D.			484–D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	1.80			2.10			0.80		
Prox. Moisture	.44	2.23		.43	2.52		.44	1.24	
Prox. Volatile matter	32.66	32.07	32.80	33.27	32.58	33.42	31.91	31.65	32.05
Prox. Fixed carbon	57.97	56.93	58.23	55.49	54.32	55.73	51.40	50.99	51.63
Prox. Ash	8.93	8.77	8.97	10.81	10.58	10.85	16.25	16.12	16.32
Ult. Sulphur	.58	.57	.58	.48	.47	.48	.54	.54	.55
Ult. Hydrogen								4.73	4.65
Ult. Carbon								69.96	70.83
Ult. Nitrogen								1.36	1.38
Ult. Oxygen								7.29	6.27
Calorific value: Determined— Calories				7,609	7,449	7,642	7,058	7,001	7,089
Determined— B. t. u.					13,408	13,756	12,704	12,602	12,760
Calculated from ultimate analysis— Calories								6,981	7,069
Calculated from ultimate analysis— B. t. u.								12,566	12,724

Denver No. 19.

A shipment of bituminous coal from the Nos. 4 and 5 beds at Taylor, King County, Wash., on the Columbia and Puget Sound Railroad, consisted of three grades of coal, designated Denver No. 19 A, B, and C. Denver No. 19A consisted of 25 tons of run-of-mine coal from the No. 5 bed and was used in making washing tests 250, 251, and 252, and coking tests 272, 273, and 294.

Denver No. 19B consisted of 15 tons of washed coal from the No. 5 bed and was used in making coking tests 269 and 270. Denver No. 19C consisted of 10 tons of run-of-mine coal from the No. 4 bed and was used in making washing test 253 and coking test 274.

Three mine samples were taken for chemical analysis. Sample 520–D was taken from No. 5 bed, 3,000 feet northwest of the drift mouth, where the coal measured as shown in section A; sample 518–D was taken from the same bed, 2,400 feet northeast of the drift mouth, where the coal measured as shown in section B; sample 519–D was taken from the No. 4 bed, 1,500 feet northeast of the drift mouth, where the coal measured as shown in section C.

[a] Not included in sample.

Section A (sample 520–D).

	Ft.	in.
Coal		5
Shale and sandstone		¼
Coal		5¼
Shale and sandstone [a]		1
Coal		1½
Rash [a]		2¼
Coal	1	11
Foot wall, bone coal.		
	3	2¼

Section B (sample 518–D).

	Ft.	in.
Coal		5½
Shale [a]		1
Coal	1	1
Rash [a]		1½
Coal	2	1
Foot wall, bone coal.		
	3	10

Section C (sample 519–D).

	Ft.	in.
Coal	2	3½
Bone coal		4
Foot wall, bone coal.		
	2	7½

Chemical analyses of Denver No. 19 coal.

	Mine samples.						Car sample 19A (586–D).		
	518–D.			519–D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	2.20			3.30			2.30		
Prox. Moisture	1.92	4.08		2.13	5.36		3.12	5.35	
Prox. Volatile matter	36.69	35.88	37.41	38.97	37.68	39.81	34.97	34.17	36.10
Prox. Fixed carbon	44.52	43.54	45.39	50.00	48.35	51.09	38.69	37.81	39.95
Prox. Ash	16.87	16.50	17.20	8.90	8.61	9.10	23.22	22.67	23.95
Ult. Sulphur	.55	.54	.55	.65	.63	.67	.79	.77	.81
Ult. Hydrogen								4.72	4.36
Ult. Carbon								56.98	60.20
Ult. Nitrogen								1.37	1.45
Ult. Oxygen								13.49	9.23
Calorific value: Determined— Calories	6,564	6,420	6,693	7,093	6,859	7,247	5,862	5,728	6,052
B. t. u.		11,556	12,047		12,344	13,045	10,552	10,310	10,894
Calculated from ultimate analysis— Calories								5,665	5,985
B. t. u.								10,197	10,773

	Mine sample (520–D).			Car sample 19C (585–D).		
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	3.50			2.60		
Prox. Moisture	2.76	6.16		3.70	6.20	
Prox. Volatile matter	41.43	39.98	42.61	35.11	34.20	36.46
Prox. Fixed carbon	39.15	37.78	40.25	42.46	41.37	44.10
Prox. Ash	16.66	16.08	17.14	18.73	18.23	19.44
Ult. Sulphur	1.05	1.01	1.08	.71	.69	.74
Ult. Hydrogen					4.95	4.54
Ult. Carbon					60.12	64.09
Ult. Nitrogen					1.41	1.50
Ult. Oxygen					14.60	9.69
Calorific value: Determined— Calories				6,209	6,049	6,448
B. t. u.				11,176	10,888	11,606
Calculated from ultimate analysis— Calories					5,948	6,341
B. t. u.					10,706	11,414

[a] Not included in sample.

Denver No. 20.

Bituminous coal from the No. 3 bed at Carbonado, Pierce County, Wash., on the Northern Pacific Railroad, was designated Denver No. 20.

This shipment consisted of 50 tons of run-of-mine coal and was used in making washing tests 264, 265, and 266, and coking tests 287, 288, 289, 290, and 294.

One sample only, 522–D, was taken for chemical analysis. It was taken from the face of No. 3, north entry, 14,000 feet east of the drift mouth, where the coal measured as shown in section A.

Section A (sample 552–D).

	Ft.	in.
Coal	1	10
Shale [a]		4
Coal	1	10
Shale [a]		1¼
Coal		10
Shale [a]		1
Coal		7
Shale [a]		2
Coal	2	4
Foot wall, bone coal.		
	8	1¼

Chemical analyses of Denver No. 20 coal.

	Mine sample (552–D).			Car sample (787–D).		
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	1.80			3.30		
Prox. Moisture	1.12	2.90		1.41	4.66	
Prox. Volatile matter	31.51	30.94	31.87	30.06	29.07	30.49
Prox. Fixed carbon	51.04	50.12	51.61	52.03	50.31	52.77
Prox. Ash	16.33	16.04	16.52	16.50	15.96	16.74
Ult. Sulphur	.47	.46	.47	.47	.45	.47
Ult. Hydrogen					4.95	4.65
Ult. Carbon					67.18	70.47
Ult. Nitrogen					2.11	2.21
Ult. Oxygen					9.35	5.46
Calorific value: Determined— Calories	7,037	6,907	7,117	6,970	6,740	7,070
Determined— B. t. u.		12,433	12,810	12,546	12,132	12,726
Calculated from ultimate analysis— Calories					6,740	7,069
Calculated from ultimate analysis— B. t. u.					12,132	12,725

Denver No. 21.

A shipment of bituminous coal from the Roslyn bed, 3 miles west of Roslyn, Kittitas County, Wash., on the Northern Pacific Railroad, consisted of two grades of coal, which were designated Denver

[a] Not included in sample.

No. 21 A and B. Denver No. 21A consisted of 16 tons of run-of-mine coal and was used in making washing test 256 and coking tests 277 and 279. Denver No. 21B consisted of 34 tons of ¾-inch screenings and was used in making washing tests 257, 258, and 270, and coking tests 278, 280, and 281.

Two mine samples were taken for chemical analysis. Sample 551–D was taken 1,300 feet southwest of the slope, where the coal measured as shown in section A; sample 550–D was taken 1,000 feet southwest of the slope, where the coal measured as shown in section B.

Section A (sample 551–D).

	Ft.	in.
Coal	2	9½
Hard shale [a]		¾
Coal	1	10
Shale [a]		½
Coal		1½
Floor, shale.		
	4	10¼

Section B (sample 550–D).

	Ft.	in.
Coal		1
Mother coal		¼
Coal	2	3
Shale [a]		1
Coal		4
Shale [a]		¾
Coal		6¼
Shale [a]		¾
Coal	1	1½
Shale [a]		½
Coal		2
Floor, shale.		
	4	9

Chemical analyses of Denver No. 21 coal.

	Mine samples.						Car samples.				
	550-D.			551-D.			21A (693-D).			21B (694-D).	
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	As received.	Dry coal.
Air-drying loss	1.90			7.60			5.80				
Prox. Moisture	1.59	3.46		1.50	8.99		2.16	7.82		2.32	
Prox. Volatile matter	39.17	38.42	39.82	39.21	36.23	39.81	35.10	33.06	35.89	37.02	37.90
Prox. Fixed carbon	49.23	48.30	50.01	49.83	46.04	50.59	47.69	44.94	48.73	47.08	48.20
Prox. Ash	10.01	9.82	10.17	9.46	8.74	9.60	15.05	14.18	15.38	13.58	13.90
Ult. Sulphur	.42	.41	.43	.38	.35	.39	.48	.45	.49	.60	.61
Ult. Hydrogen								5.48	5.00	4.67	4.51
Ult. Carbon								64.67	70.16	66.77	68.36
Ult. Nitrogen								1.41	1.53	.61	.62
Ult. Oxygen								13.81	7.44	13.77	12.00
Calorific value: Determined— Calories	7,489	7,347	7,610				7,019	6,613	7,174	6,913	7,078
Determined— B. t. u.		13,225	13,698				12,634	11,903	12,913	12,443	12,740
Calculated from ultimate analysis— Calories								6,529	7,083	6,425	6,578
Calculated from ultimate analysis— B. t. u.								11,751	12,749	11,565	11,840

[a] Not included in sample.

Denver No. 22.

Bituminous coal from a mine 1 mile west of Lombard, Broadwater County, Mont., on the Northern Pacific Railroad, was designated Denver No. 22.

This shipment consisted of 45 tons of run-of-mine coal and was used in making washing tests 254 and 255 and coking tests 275 and 276.

Two mine samples were taken for chemical analysis. Sample 563–D was taken 300 feet north of the slope, where the coal measured as shown in section A; sample 564–D was taken 400 feet northeast of the slope, where the coal measured as shown in section B.

Section A (sample 563–D).

	Ft.	in.
Roof, coal.		
Coal		11½
Shale and mother coal		¾
Coal	7	6
Floor, coal.		
	8	6¼

Section B (sample 564–D).

	Ft.	in.
Roof, coal.		
Coal	1	3
Shale		¾
Coal	5	3
Floor, coal.		
	6	6¾

Note.—Small sulphur lenses are scattered promiscuously through the coal bed.

Chemical analyses of Denver No. 22 coal.

	Mine samples.						Car sample (662–D).		
	563–D.			564–D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	2.30	.....	.....	3.10	.....	.....	1.60	.....	.....
Prox. Moisture	.49	2.78	.....	.58	3.67	.....	1.46	3.04	.....
Prox. Volatile matter	25.11	24.53	25.23	26.57	25.74	26.72	20.01	19.69	20.31
Prox. Fixed carbon	43.96	42.95	44.18	53.68	52.01	53.99	40.14	39.50	40.72
Prox. Ash	30.44	29.74	30.59	19.17	18.58	19.29	38.39	37.77	38.97
Ult. Sulphur	8.42	8.23	8.46	7.20	6.98	7.25	7.81	7.69	7.93
Ult. Hydrogen	.....	.....	.....	.....	.....	.....	.....	3.16	2.91
Ult. Carbon	.....	.....	.....	.....	.....	.....	.....	44.16	45.54
Ult. Nitrogen	.....	.....	.....	.....	.....	.....	.....	.49	.49
Ult. Oxygen	.....	.....	.....	.....	.....	.....	.....	6.73	4.16
Calorific value: Determined— Calories	5,722	5,590	5,750	.....	.....	.....	4,576	4,503	4,643
Determined— B. t. u.	.....	10,062	10,350	.....	.....	.....	8,237	8,105	8,357
Calculated from ultimate analysis— Calories	.....	.....	.....	.....	.....	.....	.....	4,541	4,683
Calculated from ultimate analysis— B. t. u.	.....	.....	.....	.....	.....	.....	.....	8,174	8,430

Denver No. 23.

Bituminous coal from the Cherokee bed, 3 miles north of Frontenac, Crawford County, Kans., on the Atchison, Topeka and Santa Fe Railroad, was designated Denver No. 23.

This shipment consisted of 50 tons of run-of-mine coal and was used in making washing tests 259, 260, 261, 262, and 263, and coking tests 282, 283, 284, 285, and 286.

Two mine samples were taken for chemical analysis. Sample 660–D was taken 4,000 feet west of the shaft, where the coal measured as shown in section A; sample 661–D was taken 3,000 feet south of the shaft, where the coal measured as shown in section B.

Section A (sample 660–D).

Roof, shale.	Ft.	In.
Coal		8
Shale and sandstone [a]		½
Coal		2
Mother coal		⅛
Coal		9¼
Bone coal		¼
Coal		5¾
Mother coal and shale		¼
Coal		9¼
Floor, fire clay.		
	2	11⅜

Section B (sample 661–D).

Roof, shale.	Ft.	In.
Coal		5½
Sulphur		¼
Coal		2¼
Mother coal		¼
Coal		10¼
Mother coal		¼
Coal	1	6
Floor, fire clay.		
	3	¾

Chemical analyses of Denver No. 23 coal.

	Mine samples.						Car sample (701–D).		
	660–D.			661–D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	3.30	.....	.....	4.10	.....	.....	2.80	.....	.....
Prox. Moisture	2.05	5.28	.....	2.08	6.09	.....	3.03	5.75	.....
Prox. Volatile matter	35.11	33.95	35.85	34.20	32.80	34.93	34.24	33.28	35.28
Prox. Fixed carbon	53.37	51.61	54.48	52.58	50.43	53.69	48.65	47.29	50.21
Prox. Ash	9.47	9.16	9.67	11.14	10.68	11.38	14.08	13.68	14.51
Ult. Sulphur	4.13	3.99	4.21	5.99	5.74	6.11	5.22	5.07	5.38
Ult. Hydrogen	.....	.....	.....	.....	.....	.....	.....	5.01	4.64
Ult. Carbon	.....	.....	.....	.....	.....	.....	.....	66.68	70.75
Ult. Nitrogen	.....	.....	.....	.....	.....	.....	.....	1.15	1.22
Ult. Oxygen	.....	.....	.....	.....	.....	.....	.....	8.41	3.50
Calorific value: Determined— Calories	7,476	7,229	7,632	.....	.....	.....	6,915	6,721	7,132
Determined— B. t. u.	.....	13,012	13,738	.....	.....	.....	12,447	12,098	12,838
Calculated from ultimate analysis— Calories	.....	.....	.....	.....	.....	.....	.....	6,866	7,285
Calculated from ultimate analysis— B. t. u.	.....	.....	.....	.....	.....	.....	.....	12,359	13,113

[a] Not included in sample.

Denver No. 24.

A shipment consisting of 25 tons of refuse from a washery at Starkville, Las Animas County, Colo., was designated Denver No. 24. Washing tests 276 and 277 were made. No mine samples were taken in connection with this shipment. No ultimate analysis of the coal was made.

Proximate chemical analysis of Denver No. 24 coal (car sample 838–D).

	As received.	Dry coal.
Moisture	2.64	.....
Volatile matter	19.60	20.13
Fixed carbon	25.27	25.96
Ash	52.49	53.91
Sulphur	.41	.42

Denver No. 25.

Bituminous coal from a mine working the "Cameron" bed, 1½ miles southwest of Rugby, Las Animas County, Colo., on the Colorado and Southern Railway, was designated Denver No. 25.

This shipment consisted of 40 tons of 1-inch screenings and was used in making washing tests 267, 268, and 269, and coking tests 291, 292, 295, and 296.

Two mine samples were taken for chemical analysis. Sample 734–D was taken 250 feet north of the drift mouth, where the coal measured as shown in section A; sample 735–D was taken 250 feet south of the drift mouth, where the coal measured as shown in section B.

Section A (sample 734–D).

Roof, shale.	Ft.	in.
Coal		1½
Mother coal		⅜
Coal		6½
Bone coal [a]		1½
Coal		9½
Sulphur		¼
Coal		7
Bone coal		1½
Coal	1	4¼
Floor, shale.		
	3	8⅜

Section B (sample 735–D).

Roof, shale.	Ft.	in.
Coal		6¾
Bone coal [a]		1½
Coal		5½
Bone coal [a]		1¼
Coal		3¾
Sulphur		¼
Coal	1	11½
Floor, shale.		
	3	6¼

[a] Not included in sample.

Chemical analyses of Denver No. 25 coal.

	Mine samples.						Car sample (805–D).		
	734–D.			735–D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	1.10	.....	.....	1.60	.....	.....	1.40	.....	.....
Prox. Moisture	2.20	3.28	.....	2.21	3.77	.....	1.73	3.11	.....
Prox. Volatile matter	36.48	36.08	37.31	37.14	36.55	37.98	35.72	35.22	36.35
Prox. Fixed carbon	52.02	51.44	53.18	52.09	51.26	53.27	48.36	47.68	49.21
Prox. Ash	9.30	9.20	9.51	8.56	8.42	8.75	14.19	13.99	14.44
Ult. Sulphur	.73	.72	.74	.71	.70	.73	.82	.81	.84
Ult. Hydrogen	.....	.....	.....	.....	.....	.....	.....	4.86	4.65
Ult. Carbon	.....	.....	.....	.....	.....	.....	.....	67.60	69.77
Ult. Nitrogen	.....	.....	.....	.....	.....	.....	.....	1.36	1.40
Ult. Oyxgen	.....	.....	.....	.....	.....	.....	.....	11.38	8.90
Calorific value:									
Determined—									
Calories	7,258	7,178	7,421	.....	.....	.....	6,870	6,775	6,992
B. t. u.	.....	12,920	13,358	.....	.....	.....	12,366	12,195	12,586
Calculated from ultimate analysis—									
Calories	.....	.....	.....	.....	.....	.....	.....	6,666	6,880
B. t. u.	.....	.....	.....	.....	.....	.....	.....	11,998	12,383

Denver No. 26.

Subbituminous coal from the lower bed at Lafayette, Boulder County, Colo., on the Colorado and Southern Railway, was designated Denver No. 26.

This shipment consisted of 40 tons of run-of-mine coal and was used in making coking test 293.

Two mine samples were taken for chemical analysis. Sample 792–D was taken 1,500 feet southwest of the shaft, where the coal measured as shown in section A; sample 793–D was taken 3,000 feet west of the shaft, where the coal measured as shown in section B.

Section A (sample 792–D).

Roof, coal.	Ft.	in.
Coal	2	11½
Mother coal and sulphur		¼
Coal		7½
Mother coal and sulphur		¼
Coal	3	5
Floor, bastard fire clay.		
	7	½

Section B (sample 793–D).

Roof, coal.	Ft.	in.
Coal	4	2
Bone coal		1½
Coal	2	9
Floor, bastard fire clay.		
	7	½

Chemical analyses of Denver No. 26 coal.

	Mine samples.						Car sample (803–D).		
	792–D.			793–D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	1.30			5.40			5.50		
Prox. Moisture	17.70	18.77		16.58	21.08		14.58	19.28	
Prox. Volatile matter	37.77	37.28	45.90	41.60	39.35	49.86	36.62	34.61	42.87
Prox. Fixed carbon	40.50	39.97	49.20	38.22	36.16	45.82	43.83	41.41	51.30
Prox. Ash	4.03	3.98	4.90	3.60	3.41	4.32	4.97	4.70	5.83
Ult. Sulphur	.30	.30	.37	.36	.36	.46	.41	.39	.48
Ult. Hydrogen								5.99	4.77
Ult. Carbon								57.94	71.78
Ult. Nitrogen								1.28	1.58
Ult. Oxygen								29.70	15.56
Calorific value: Determined—									
Calories	5,678	5,604	6,899				5,917	5,591	6,926
B. t. u.		10,087	12,418				10,651	9,064	12,467
Calculated from ultimate analysis—									
Calories								5,476	6,784
B. t. u.								9,857	12,211

Denver No. 27.

Bituminous coal from the "Berwind" bed, 1 mile west of Berwind, Las Animas County, Colo., on the Colorado and Southern Railway, was designated Denver No. 27.

This shipment consisted of 40 tons of run-of-mine coal and was used in making washing test 271 and coking tests 297, 300, 301, and 302.

As this was an undeveloped mine, only one mine sample was taken for chemical analysis. Sample 796–D was taken 180 feet southwest of the shaft, where the coal measured as shown in section A.

Section A (sample 796–D).

	Ft.	In.
Roof, bone coal.		
Coal	5	11½
Floor, sandstone.		

Chemical analyses of Denver No. 27 coal.

	Mine sample (796–D).			Car sample (880–D).		
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	5.80			2.60		
Prox. Moisture	.67	6.43		1.66	4.22	
Prox. Volatile matter	33.78	31.82	34.00	33.24	32.38	33.80
Prox. Fixed carbon	50.92	47.97	51.27	51.57	50.22	52.44
Prox. Ash	14.63	13.78	14.73	13.53	13.18	13.76
Ult. Sulphur	.59	.56	.60	.66	.64	.67
Ult. Hydrogen					5.14	4.88
Ult. Carbon					70.69	73.80
Ult. Nitrogen					1.20	1.25
Ult. Oxygen					9.15	5.64
Calorific value: Determined—						
Calories	7,207	6,789	7,256	7,233	7,045	7,355
B. t. u.		12,220	13,061	13,019	12,681	13,239
Calculated from ultimate analysis—						
Calories					7,105	7,418
B. t. u.					12,789	13,352

Denver No. 28.

Bituminous coal from a bed at Cameo, Mesa County, Colo., on the Denver and Rio Grande and Colorado Midland railroads, was designated Denver No. 28.

This shipment consisted of 40 tons of 4-inch run-of-mine coal and was used in making washing test 272 and coking tests 298, 303, and 305.

Two mine samples were taken for chemical analysis. Sample 839–D was taken 3,500 feet northwest of the drift mouth, where the coal measured as shown in section A; sample 840–D was taken 3,700 feet northwest of the drift mouth, where the coal measured as shown in section B.

Section A (sample 839–D).

	Ft.	in.
Roof, shale.		
Coal	1	10½
Hard shale [a]		1
Coal	3	6
Floor, bone coal.		
	5	5½

Section B (sample 840–D).

	Ft.	in.
Roof, shale.		
Coal	2	2½
Shale [a]		¾
Coal	2	6
Shale and bone [a]		5
Coal	1	2¾
Floor, bone coal.		
	6	5

Chemical analyses of Denver No. 28 coal.

	Mine samples.						Car sample (852-D).		
	839-D.			840-D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	1.70			2.10			3.60		
Prox. Moisture	5.50	7.11		5.44	7.43		5.10	8.52	
Prox. Volatile matter	35.82	35.21	37.90	36.98	36.20	39.11	35.25	33.98	37.15
Prox. Fixed carbon	49.15	48.31	52.01	49.65	48.62	52.52	46.89	45.20	49.40
Prox. Ash	9.53	9.37	10.09	7.92	7.75	8.37	12.76	12.30	13.45
Ult. Sulphur	.59	.58	.62	.57	.56	.61	.60	.58	.63
Ult. Hydrogen								5.38	4.84
Ult. Carbon								64.50	70.51
Ult. Nitrogen								1.31	1.43
Ult. Oxygen								15.93	9.14
Calorific value: Determined— Calories				6,915	6,770	7,314	6,523	6,288	6,873
Calorific value: Determined— B. t. u.					12,186	13,165	11,741	11,318	12,371
Calculated from ultimate analysis— Calories								6,393	6,988
Calculated from ultimate analysis— B. t. u.								11,507	12,579

[a] Not included in sample.

Denver No. 29.

Bituminous coal from the upper part of the coal-basin bed at Coalbasin, Pitkin County, Colo., on the Crystal River Railroad, was designated Denver No. 29.

This shipment consisted of 25 tons of run-of-mine coal and was used in making washing tests 274 and 275 and coking tests 299, 306, and 307.

Two mine samples were taken for chemical analysis. Sample 5255 was taken on the second level on the right of the slope, where the coal measured as shown in section A; sample 5346 was taken in No. 58 slant, where the coal measured as shown in section B.

Section A (sample 5255).

	Ft.	in.
Coal (soft)	3	3
Coal	2	4
Bone coal[a]	1	4
	6	11

Section B (sample 5346).

	Ft.	in.
Coal	6	6

Chemical analyses of Denver No. 29 coal.

	Mine samples.						Car sample (894-D).		
	5255.			5346.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	0.40	.....	.....	1.20	.....	.....	1.80	.....	.....
Prox. Moisture	.80	1.20	.....	1.20	2.39	.....	1.29	3.07	.....
Prox. Volatile matter	22.48	22.39	22.66	19.68	19.44	19.92	23.09	22.67	23.39
Prox. Fixed carbon	73.20	72.90	73.79	71.62	70.76	72.49	66.29	65.10	67.16
Prox. Ash	3.52	3.51	3.55	7.50	7.41	7.59	9.33	9.16	9.45
Ult. Sulphur	.74	.74	.75	.53	.52	.53	.64	.63	.65
Ult. Hydrogen	.....	.....	.....	.....	.....	.....	.....	4.96	4.77
Ult. Carbon	.....	.....	.....	.....	.....	.....	.....	78.81	81.31
Ult. Nitrogen	.....	.....	.....	.....	.....	.....	.....	1.69	1.74
Ult. Oxygen	.....	.....	.....	.....	.....	.....	.....	4.75	2.08
Calorific value: Determined— Calories	.....	.....	.....	8,084	7,987	8,183	7,915	7,772	8,018
Calorific value: Determined— B. t. u.	.....	.....	.....	.....	14,377	14,729	14,247	13,990	14,432
Calculated from ultimate analysis— Calories	.....	.....	.....	.....	.....	.....	.....	7,888	8,138
Calculated from ultimate analysis— B. t. u.	.....	.....	.....	.....	.....	.....	.....	14,198	14,648

Denver No. 30.

Bituminous coal from the lower part of the coal-basin bed (not being worked at present) at Coalbasin, Pitkin County, Colo., on the Crystal River Railroad, was designated Denver No. 30.

This shipment consisted of 17 tons of run-of-mine coal and was used in making washing tests 273 and 275 and coking tests 304 and 307.

[a] Not included in sample.

This coal is from the same bed as Denver No. 29, being the lower part of it. This is the floor coal of the sections shown in Denver No. 29, and is called bone coal because it contains more impurities than the upper part of the coal bed.

Two mine samples were taken for chemical analysis. Sample 5262 was taken in the main slope air course, where the coal measured as shown in section A; sample 5249 was taken in the second level on the right of the slope, where the coal measured as shown in section B.

Section A (sample 5262).

	Ft.	in.
Coal.[a]		
Bone coal	3	10

Section B (sample 5249).

	Ft.	in.
Coal[a]	6	6
Bone coal	5	0
	11	6

Chemical analyses of Denver No. 30 coal.

	Mine samples.						Car sample (888-D).		
	5262.			5249.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	0.40	.....	.....	0.30	.....	.....	3.10	.....	.....
Prox. Moisture	1.28	1.67	.....	1.30	1.60	.....	.67	3.75	.....
Prox. Volatile matter	21.41	21.32	21.68	19.66	19.60	19.92	22.83	22.12	22.98
Prox. Fixed carbon	67.99	67.73	68.88	59.56	59.38	60.34	64.40	62.41	64.84
Prox. Ash	9.32	9.28	9.44	19.48	19.42	19.74	12.10	11.72	12.18
Ult. Sulphur	.47	.47	.48	.45	.45	.46	.41	.40	.42
Ult. Hydrogen	.....	.....	.....	.....	.....	.....	.....	4.79	4.54
Ult. Carbon	.....	.....	.....	.....	.....	.....	.....	75.80	78.75
Ult. Nitrogen	.....	.....	.....	.....	.....	.....	.....	1.45	1.51
Ult. Oxygen	.....	.....	.....	.....	.....	.....	.....	5.84	2.60
Calorific value: Determined— Calories	7,843	7,812	7,945	.....	.....	.....	7,653	7,416	7,704
Determined— B. t. u.	.....	14,062	14,301	.....	.....	.....	13,755	13,349	13,867
Calculated from ultimate analysis: Calories	.....	.....	.....	.....	.....	.....	.....	7,533	7,826
Calculated from ultimate analysis: B. t. u.	.....	.....	.....	.....	.....	.....	.....	13,559	14,087

Denver No. 31.

Bituminous coal from the "Carthage" bed, at Carthage, Socorro County, N. Mex., on the New Mexico Midland Railroad, was designated Denver No. 31.

This shipment consisted of 30 tons of run-of-mine coal and was used in making washing test 279 and coking tests 311, 312, and 313.

Two mine samples were taken for chemical analysis. Sample 890–D was taken 870 feet south of the slope mouth, where the coal measured as shown in section A; sample 889–D was taken 700 feet south of the slope mouth, where the coal measured as shown in section B.

[a] Not included in sample.

Section A (sample 890–D).

Roof, bone coal.	Ft.	in.
Coal	1	½
Shale [a]		1¾
Coal	1	2
Shale and sulphur [a]		¾
Coal	1	¾
Bastard fire clay [a]		2
Coal		8½
Coal and shale		¾
Coal		8¾
Floor, shale.		
	5	1¾

Section B (sample 889–D).

Roof, sandstone.	Ft.	in.
Coal	1	2
Shale [a]		6
Coal		6¼
Sulphur		½
Coal	1	7½
Bastard fire clay [a]		3
Coal	1	6½
Floor, shale.		
	5	7¾

Chemical analyses of Denver No. 31 coal.

	Mine samples.						Car sample (972–D).		
	889–D.			890–D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	1.30			2.10			0.60		
Prox. Moisture	2.08	3.35		1.85	3.91		2.37	2.96	
Prox. Volatile matter	39.96	39.44	40.80	39.70	38.87	40.44	37.43	37.20	38.33
Prox. Fixed carbon	50.50	49.85	51.58	47.83	46.82	48.74	45.39	45.12	46.50
Prox. Ash	7.46	7.36	7.62	10.62	10.40	10.82	14.81	14.72	15.17
Prox. Sulphur	.84	.83	.86	.72	.70	.73	.80	.79	.81
Ult. Hydrogen								4.78	4.59
Ult. Carbon								67.73	69.80
Ult. Nitrogen								1.26	1.30
Ult. Oxygen								10.71	8.32
Calorific value: Determined— Calories				7,231	7,079	7,367	6,827	6,786	6,993
Calorific value: Determined— B. t. u					12,742	13,261	12,289	12,215	12,587
Calculated from ultimate analysis— Calories								6,676	6,880
Calculated from ultimate analysis— B. t. u								12,017	12,384

Denver No. 32.

Bituminous coal from the Yampa or Lower bed, at Oak Creek, Routt County, Colo., on the Denver, Northwestern and Pacific Railroad, was designated Denver No. 32.

This shipment consisted of 40 tons of run-of-mine coal and was used in making washing test 278 and coking tests 308, 309, and 310.

Two mine samples were taken for chemical analysis. Sample 916–D was taken from the face of the main slope, 725 feet northwest of the slope mouth, where the coal measured as shown in section A; sample 915–D was taken from the face of the south slope, 700 feet northwest of the mouth, where the coal measured as shown in section B.

[a] Not included in sample.

Section A (sample 916–D).

Roof, sandstone.	Ft.	in.
Coal		6½
Shale		¼
Coal	1	6½
Hard shale[a]		10
Coal	2	7½
Floor, shale.		
	5	6¾

Section B (sample 915–D).

Roof, sandstone.	Ft.	in.
Coal		6¾
Shale		½
Coal	1	7½
Hard shale[a]		10
Coal	2	9¾
Floor, shale.		
	5	10½

Chemical analyses of Denver No. 32 coal.

	Mine samples.						Car sample (971–D).		
	915–D.			916–D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss							0.90		
Prox. Moisture		6.43			6.16		6.69	7.53	
Prox. Volatile matter		37.36	39.93		38.12	40.62	36.68	36.36	39.32
Prox. Fixed carbon		47.58	50.85		47.92	51.07	45.88	45.46	49.16
Prox. Ash		8.63	9.22		7.80	8.31	10.75	10.65	11.52
Ult. Sulphur		1.53	1.63		1.10	1.17	1.52	1.51	1.63
Ult. Hydrogen								5.29	4.81
Ult. Carbon								64.90	70.19
Ult. Nitrogen								1.41	1.52
Ult. Oxygen								16.24	10.33
Calorific value: Determined—									
Calories					6,707	7,147	6,423	6,366	6,884
B. t. u.					12,073	12,865	11,561	11,459	12,391
Calculated from ultimate analysis—									
Calories								6,400	6,921
B. t. u.								11,520	12,458

Denver No. 33.

Bituminous coal from the No. 7 bed at Sweetwater, Sweetwater County, Wyo., on the Union Pacific Railroad, was designated Denver No. 33.

This shipment consisted of 40 tons of run-of-mine coal and was used in making washing test 280 and coking tests 314 and 315.

Two mine samples were taken for chemical analysis. Sample 946–D was taken approximately 1½ miles north of the drift, where the coal measured as shown in section A; sample 945–D was taken 1½ miles north of the drift, where the coal measured as shown in section B.

Section A (sample 946–D).

Roof, sandy shale.	Ft.	in.
Coal	1	11
Shale		¼
Coal	3	11¾
Floor, sandstone.		
	5	11

Section B (sample 945–D).

Roof, sandy shale.	Ft.	in.
Coal	1	11
Shale		¼
Coal	4	¾
Floor, sandstone.		
	6	00

[a] Not included in sample.

Chemical analyses of Denver No. 33 coat.

	Mine samples.						Car sample (973–D).		
	945–D.			946–D.					
	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.	Air dried.	As received.	Dry coal.
Air-drying loss	1.40	.....	.....	1.40	.....	.....	.40	.....	.....
Prox. Moisture	7.51	8.80	.....	7.74	9.03	.....	8.27	8.64	.....
Prox. Volatile matter	39.45	38.90	42.65	38.98	38.43	42.24	38.62	38.47	42.11
Prox. Fixed carbon	50.16	49.46	54.24	50.61	49.91	54.87	48.50	48.30	52.87
Prox. Ash	2.88	2.84	3.11	2.67	2.63	2.89	4.61	4.59	5.02
Ult. Sulphur	1.00	.99	1.09	.89	.88	.97	1.09	1.09	1.19
Ult. Hydrogen	.....	.....	.....	.....	.....	.....	.....	5.53	5.00
Ult. Carbon	.....	.....	.....	.....	.....	.....	.....	69.55	76.13
Ult. Nitrogen	.....	.....	.....	.....	.....	.....	.....	1.53	1.67
Ult. Oxygen	.....	.....	.....	.....	.....	.....	.....	17.71	10.99
Calorific value: Determined— Calories	.....	.....	.....	7,033	6,935	7,623	6,791	6,764	7,404
Calorific value: Determined— B. t. u.	.....	.....	.....	.....	12,483	13,721	12,224	12,175	13,327
Calculated from ultimate analysis— Calories	.....	.....	.....	.....	.....	.....	.....	6,788	7,430
Calculated from ultimate analysis— B. t. u.	.....	.....	.....	.....	.....	.....	.....	12,218	13,373

WASHING TESTS.

By G. R. Delamater.

INTRODUCTORY STATEMENT.

The equipment and operation of the Denver washery in the previous tests were described in Bulletin 368. In brief, the run-of-mine coal from the railroad car was shoveled to a hopper scale, whence it passed through a toothed-roll crusher that broke it down to a maximum of 2½ inches. Thence an apron conveyor and a bucket elevator took the raw coal, which was sampled at the elevator, to one of six storage bins. The sample of coal was analyzed and float-and-sink tests were made on it to determine the size giving the best separation. From the storage bin the coal went to a corrugated-roll disintegrator, where it was crushed to the desired size; thence another elevator carried it to a storage bin. From this it went to the sluice boxes leading to the jigs. A Richards jig and a special jig were used. The washed coal was finely crushed by a Pennsylvania hammer crusher, then elevated to the top of the washery building and conveyed to a chute supplying the coke-oven larry.

CHANGES IN EQUIPMENT.

For the tests described in this bulletin a few changes were made in the equipment.

One 50-barrel water tank was installed and the water lines from the pump were changed to deliver direct to this tank, thus giving a head of about 30 feet to the water for the jigs. This arrangement gave much better results, as will be noted, for instance, in the tests on

the Montana coals, in which much better separations were made than were made the year before on similar coals. Changes in the sludge-tank arrangement could not be made, and in consequence the loss in the refuse continued. Riffling the tank brought about some improvement in some of the coals tested, but not in all.

A Richards regulation 4-inch four-compartment pulsator ore jig was tried in some of the tests, and later a 4-inch six-compartment jig of the same type was tried with interesting results. In some of the tests the refuse from these jigs was remarkably free from coal, but in none was the ash reduction satisfactory. However, it must be remembered that neither jig was built for cleaning coal, but was a regular ore jig. The writer believes the pulsations are as nearly perfect as in any jig, and that with careful redesigning to suit the conditions peculiar to coal, a machine can be built which will greatly assist in overcoming some of the present difficulties of coal washing. The main trouble with the jig as now constructed appears to be that the jig takes off the heavier refuse in the first two or three compartments, and it is practically impossible to obtain a bed in the others. The machine now has no trouble in removing the heavier refuse matter, but is ineffective in separating the bone and refuse matter that has a specific gravity close to that of the good coal. This defect is probably due to the fact that the designer of the machine had ore practice only in mind, in which work the specific gravity of the tailings is decidedly less than that of the concentrates and the product of each compartment is different and is kept separate after leaving the machine. However, as previously stated, the writer believes that the machine can be designed to overcome the different conditions of coal washing, and those concerned in this subject will watch with interest the development of this machine for use in the washing of coal.

FLOAT-AND-SINK TESTS.

The float-and-sink tests were made with machines, and as large a sample as possible was used, usually 2 kilograms to a test. Whereas with the old system of skimming and filtering there was difficulty in making an average of two tests a day, with the new machines now in use it is easily possible to make 30 to 35 tests a day. Another great advantage is that the liquid is not removed from the tanks throughout the tests. Much time and labor is thus saved, though, of course, most of the extra time consumed in the old method was taken up by the filtering.

Figure 1 shows the float-and-sink machine. It is composed of a wooden box about 30 inches long and 12 inches wide, with double ends and partitions *m*, *m* dividing the box into three compartments. The central compartment contains the specific gravity solution and is lined throughout with sheet zinc. Two standard laboratory sieves, *g*, with

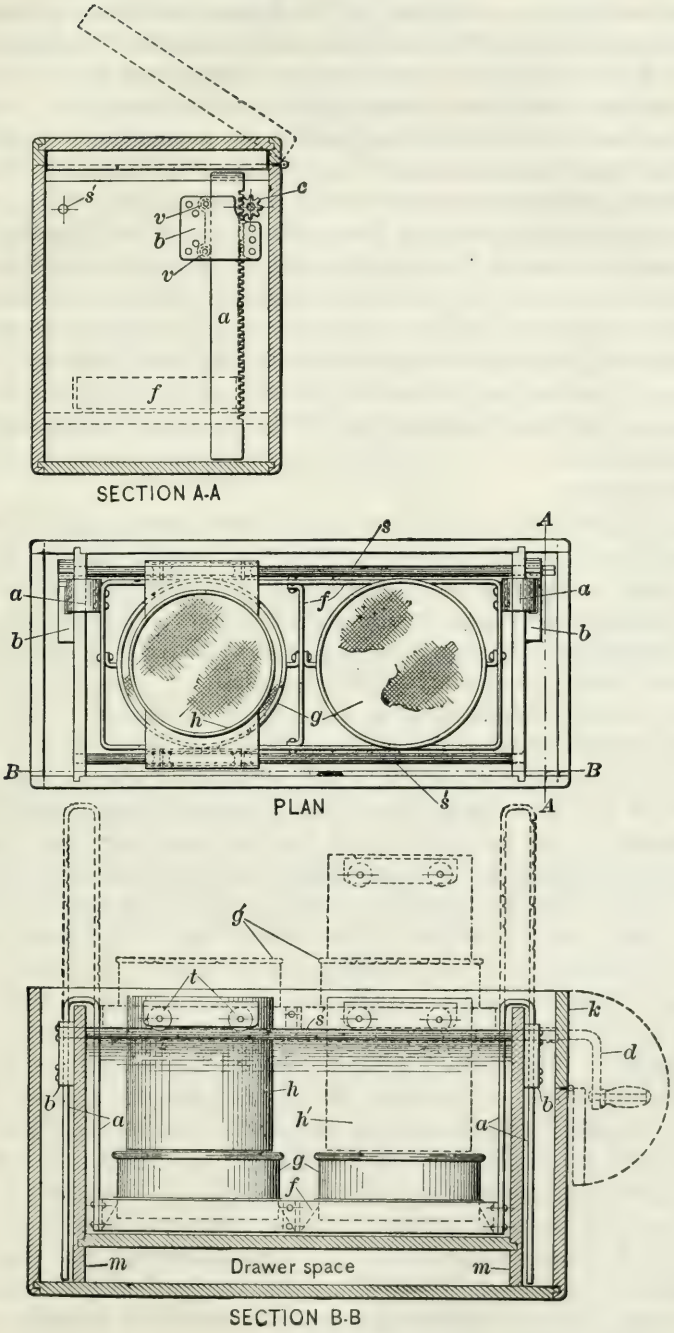

FIGURE 1.—Float-and-sink test machine.

60-mesh brass-cloth bottoms, are supported by a light iron frame, *f*. On the rear corners at each end of this frame *f* two pieces of strap iron, *a*, *a*, bent in the form of a U are riveted in the manner shown in section B–B. They straddle the partitions *m*, *m;* the rear edges of the outside legs have teeth cut therein, as shown in section A–A, and mesh with pinions, *c*, which are supported on a shaft, *s*. Guides, *b*, *b*, hold the frame extensions *a*, *a* in position, the rollers *v*, *v* allowing free vertical movement of the frame extensions *a*, *a*. When the box lid is thrown back the upper portion *k* of the box end may be opened as shown, the handle *d* then being used in turning the shaft *s* and the frame *f* being raised or lowered as desired. The outside legs of the frame extensions *a*, *a* are the longer, so that they may still remain in the guides *b*, *b* when the frame *f* is in its highest position. For this reason a false bottom is used in the central compartment to reduce the amount of liquid necessary to fill the tank, and the space beneath the false bottom is used for drawers, where the machine accessories may be kept.

The cylinder *h* is of thin plate, the diameter being a little less than that of the sieve pans; it is supported on the shafts *s* and *s'* as shown, the wheels *t* resting directly on *s* and *s'* and permitting a free movement of the cylinder from end to end of the box. When the frame *f* is in its lowest position the bottom of the cylinder *h* clears the top of the sieve pans by about an eighth of an inch.

The central compartment is filled with a solution of the desired specific gravity to about the level shown in section B–B, and the sieve pans and cylinder are placed in the positions shown in full outline, section B–B. The frame *f* is elevated until the sieve cloth touches the bottom of the cylinder *h*, and the coal sample is then deposited inside the cylinder *h*. After proper stirring to free all the particles, those lighter than the liquid float and those heavier settle to the bottom of the cylinder, resting on the screen cloth. The machine is left in this position for a few moments; then frame *f* is lowered to the bottom. The cylinder *h* is then very slowly moved to the position shown by the dotted outline *h'*, the float in the cylinder being carried over with it. The frame *f* is then elevated very slowly until entirely out of the liquid, as shown in the dotted outline *g'*, the liquid in the sieve pans filtering through the cloth bottoms and leaving the sink in the left-hand pan and the float in the other. The pans are then lifted from the frame *f* and the samples are carefully rinsed in the pans with water by means of a spray, all particles adhering to the cylinder *h* being washed into the pan containing the float. The samples are then weighed in the pans, the pan weights subtracted therefrom, and the percentages of float and sink calculated. The float sample is then ready for analysis.

Only one part of the operation of this machine requires very careful manipulation. When the cylinder is moved to the position g', it must be moved very slowly in order that there may be no disturbance of the liquid that would cause some of the float coal to be sucked down and out of the cylinder. This danger was clearly indicated in the work of this plant. After about 150 tests had been made on these machines, practically no pieces were found either floating on the liquid or in the bottom of the tanks; but a new operator lost a considerable amount in making only two tests, owing entirely to moving the cylinder over too rapidly and with a short, jerky movement. A better arrangement would be to move the cylinder by means of a small chain winding on a suitable drum. In this manner the movement of the cylinder would be uniform and as slow as desired. The pan frame should also be elevated very slowly, for otherwise, if the pans are nearly full, the pieces will be washed out.

DETAILS OF TESTS.

In the following table, in column headed "Loss of good coal in refuse," good coal means all free coal in the refuse the analysis of which is the same or nearly the same as that of the washed coal. The percentage of loss expresses the relation of the good coal in the refuse to the total of the good coal in the refuse and the washed coal. It is obtained by the following formula:

Let

x = the percentage of loss of good coal.
a = the percentage of washed coal in the sample.
b = the percentage of refuse in the sample.
c = the percentage of good coal (as defined above) in the refuse.
d = the percentage expressing the relation of the good coal in the refuse to the raw sample; that is, $bc = d$.

Then

$$x = \frac{100d}{a+d}$$

General data of washing tests at Denver, Colo., 1908–9.

Denver No.	Test No.	Date.	Duration.	Size of coal.		Jig used.[a]		Raw coal used.	Washed coal.		Refuse.		Loss of good coal in refuse.
				As shipped.	As washed.	Name.	Speed.		Amount.	Per cent.	Amount.	Per cent.	
		1908.	*H. m.*				*R.p.m.*	*Tons.*	*Tons.*		*Tons.*		*P.ct.*
15A	232	Aug. 25	2 35	R. o. m.	¾ inch.	Special	112	7.36	5.50	75	1.86	25	18
15A	233	Aug. 27	2 45	do	do	do	108	6.90	5.33	77	1.57	23	16
15A	234	Aug. 28	1 45	do	do	do	108	7.13	6.27	88	.86	12	8
15A	235	Aug. 29	2	do	do	do	108	6.97	6.43	92	.54	8	3
15B	236	Sept 1	2 20	Slack	Slack	do	108	6.57	5.32	81	1.25	19	9
15B	238	Sept. 4	5	do	⅜ inch.	Richards	86	5.91	5.59	95	.32	5	0.4
15B	239	Sept. 7	6	do	do	do	86	6.51	6.11	94	.40	6	2
15B	240	Sept. 8	2 45	do	do	do	86	6.01	5.81	97	.20	3	0.7
16	242	Sept. 14	3 55	R. o. m.	¾ inch.	Special	108	14.78	12.63	85	2.15	15	6
16	247	Sept. 23	3 30	do	¾ inch.	Richards	86	13.34	11.23	85	2.11	15	11
16	249	Sept. 28	3 20	do	do	do	86	11.36	9.66	85	1.70	15	11
17	237	Sept. 2	5 10	do	¾ inch.	Special	108	18.14	12.88	71	5.26	29	19
17	241	Sept. 9	4 15	do	⅜ inch.	Richards	86	4.69	3.99	85	.70	15	7
17	244	Sept. 16	2	do	do	do	86	8.00	6.40	80	1.60	20	11
18	243	Sept. 15	3 10	do	¾ inch.	Special	108	13.99	11.35	81	2.64	19	6
18	245	Sept. 19	1 35	do	⅜ inch.	Richards	86	5.63	4.90	87	.73	13	3
18	246	Sept. 21	1 50	do	do	do	86	5.99	4.40	74	1.59	26	18
18	248	Sept. 24	1 40	do	¾ inch.	Special	108	7.19	5.97	83	1.22	17	5
19A	250	Oct. 2	2	do	¾ inch.	Richards	86	6.67	3.80	57	2.87	43	28
19A	251	Oct. 3	1 55	do	¾ inch.	Special	110	8.66	5.80	67	2.86	33	17
19A	252	Oct. 6	3 15	do	⅜ inch.	Richards	86	7.06	4.65	66	2.41	34	21
19C	253	Oct. 7	3 40	do	do	do	86	6.51	4.33	67	2.18	33	22
22	254	Oct. 13	6 30	do	do	do	75	6.76	4.73	70	2.03	30	6
22	255	Oct. 15	5 30	do	¾ inch.	Special	110	13.55	4.20	31	9.35	69	25
21A	256	Oct. 21	2	do	do	do	110	8.92	7.83	88	1.09	12	3
21B	257	Oct. 21	55	¾ inch.	do	do	120	7.43	6.30	85	1.13	15	8
21B	258	Oct. 23	4 25	do	⅜ inch.	Richards	75	6.25	5.01	80	1.24	20	14
21B	270	Nov. 28	3	do	do	do	81	3.11	2.77	89	.34	11	8
23	259	Oct. 24	2 10	R. o. m.	¾ inch.	Special	120	6.48	4.34	67	2.14	33	18
23	260	Oct. 27	1 55	do	do	do	108	10.58	6.24	59	4.34	41	20
23	261	Oct. 27	3	do	do	do	108	10.09	6.90	68	3.19	32	20
23	262	Oct. 30	6	do	⅝ inch	Richards	75	8.23	6.34	77	1.89	23	17
23	263	Nov. 3	2 15	do	¾ inch.	Special	108	7.30	5.65	77	1.65	23	11
20	264	Nov. 5	4 40	do	do	do	108	10.68	10.04	94	.64	6	1
20	265	Nov. 6	2 40	do	do	do	108	9.01	6.88	76	2.13	24	6
20	266	Nov. 7	5 20	do	do	do	108	11.84	10.06	85	1.78	15	5
25	267	Nov. 12	3 10	1-inch scn'gs.	⅝ inch.	do	108	14.83	12.16	82	2.67	18	6
25	268	Nov. 17	40	do	do	do	108	3.82	3.13	82	.69	18	11
25	269	Nov. 21	3	do	do	Richards	96	4.53	3.94	87	.59	13	9
27	271	Dec. 4	3 20	R. o. m.	¾ inch.	Special	108	18.51	15.55	84	2.96	16	8
28	272	Dec. 5	1 25	do	do	do	108	9.74	8.50	87	1.24	13	4
30	273	Dec. 7	2	do	do	do	108	7.71	6.55	85	1.16	15	6
29	274	Dec. 9	1 25	do	do	do	108	10.70	6.43	60	4.27	40	29
29 30	275	Dec. 10	2 30	do	do	do	108	11.14	9.02	81	2.12	19	9
24	276	Dec. 14	4 30	1½ inch.	¾ inch.	Richards	81	13.58	2.58	19	11.00	81	57
24	277	Dec. 1	5	do	1½ inch	do	81	8.89	1.60	18	7.29	82	44
32	278	Dec. 23	3 10	R. o. m.	¾ inch.	Special	108	13.69	12.00	88	1.69	12	4
31	279	Dec. 26	2 25	do	do	do	108	12.86	11.10	86	1.76	14	2
33	280	Dec. 29	3	do	do	do	108	10.90	10.68	98	.22	2	0.7

[a] The special jig has a 2½-inch stroke. In the Richards jig the number of pulsations per minute is twice the number of revolutions.

As in the previous year's work, all analyses are reduced to a dry basis to afford better comparison of the test results.

In the following tables of analyses the columns headed "Percentage of reductions" show the proportionate difference between the percentage of the stated impurity in the raw coal and in the washed coal. The columns headed "Percentage removed" give, with reference to the quantity of the stated impurity in the raw coal, the proportion removed by washing. These figures are determined by the following formulæ:

Let

X = the percentage of reduction of any constituent.
Y = the percentage of any constituent removed by washing.
M = the percentage that the amount of the constituent in the washed coal is of the raw coal.
a = the percentage that the washed coal is of the raw coal.
b = the percentage of the constituent in the washed coal.
c = the percentage of the constituent in the raw coal.

Then

$$X = \frac{(c-b)}{c},\ M = ab,\ \text{and}\ Y = \frac{(c-M)}{c}$$

Analyses of coals at Denver, Colo., 1908–9.

[All reduced to a dry basis for better comparison.]

Denver No.	Raw coal.				Wash'g test No.	Washed coal.								Refuse.			
								Ash.			Sulphur.						
	Volatile matter.	Fixed carbon.	Ash.	Sulphur.		Volatile matter.	Fixed carbon.	Per cent.	Per cent of reduction.	Per cent removed.	Per cent.	Per cent of reduction.	Per cent removed.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.
15A	37.51	53.10	9.39	1.23	232	38.68	54.09	7.23	23	42	1.12	9	32	35.07	49.64	15.29	1.92
					233	38.45	54.67	6.88	27	37	1.08	12	24	31.69	50.51	17.80	1.73
					234	40.60	52.19	7.21	23	32	1.08	12	23	32.12	45.01	22.87	1.83
					235	39.25	53.23	7.52	20	26	1.10	11	18	26.81	40.40	32.79	2.61
15B	36.30	51.22	12.48	1.04	236	39.53	53.23	7.24	42	48	1.09	....	7	28.86	36.36	34.78	1.91
					238	37.10	52.59	10.31	17	22	1.14	....	....	17.32	9.38	73.30	2.04
					239	37.55	53.72	8.73	30	34	1.02	2	8	24.70	19.74	55.56	2.34
					240	35.31	54.60	10.09	19	22	.99	5	7	19.45	24.91	55.64	1.97
16	31.43	54.07	14.50	.66	242	31.67	56.74	11.59	20	32	.67	....	14	22.42	36.42	41.16	.75
					247	31.82	55.78	12.40	14	27	.66	....	15	25.61	45.04	29.35	.68
					249	30.85	56.84	12.31	15	28	.73	....	6	26.82	47.80	25.38	.55
17	31.96	49.88	18.16	.69	237	34.12	52.97	12.91	29	44	.74	....	16	27.56	41.18	31.26	1.03
					241	35.22	50.09	14.69	19	22	.69	....	4	25.30	36.87	37.83	.79
					244	33.23	51.80	14.97	18	26	.61	12	19	26.74	42.00	31.26	.69
18	32.05	51.63	16.32	.55	243	32.89	57.41	9.70	41	52	.52	5	24	25.24	34.64	40.12	.50
					245	31.63	56.26	12.11	26	32	.53	4	13	25.55	29.19	45.26	1.88
					246	31.15	56.20	12.65	22	43	.59	....	20	28.43	43.12	28.45	.46
					248	33.16	54.98	11.86	27	44	.52	5	27	26.81	34.36	38.83	.45
19A	36.10	39.95	23.95	.81	250	35.72	46.98	17.30	28	44	.83	....	20	34.13	32.95	32.92	.84
					251	37.03	46.84	16.13	31	55	.92	....	23	28.96	31.91	39.13	.99
					252	35.45	45.65	18.90	21	48	.76	6	38	33.60	32.39	34.01	1.04
19C	36.46	44.10	19.44	.74	253	36.56	48.04	15.40	21	47	.70	5	36	32.52	39.50	27.98	.73
22	20.31	40.72	38.97	7.93	254	24.10	45.64	30.26	22	55	4.17	47	69	17.61	23.33	59.06	11.16
					255	27.65	57.76	14.59	62	84	3.39	57	81	19.34	30.48	50.18	13.79
21A	34.06	49.86	16.08	.82	256	36.35	53.23	10.42	35	43	.74	10	21	24.68	26.34	48.98	2.21
21B	37.90	48.20	13.90	.61	257	38.42	51.11	10.47	25	36	.67	....	7	29.88	35.69	34.43	2.16
					258	38.18	50.59	11.23	19	32	.62	....	15	34.00	41.12	24.88	.99
					270	35.74	52.07	12.19	12	29	.52	15	31	30.18	41.60	28.22	.80
					259	38.69	54.29	7.02	52	60	3.29	39	50	31.39	38.57	30.04	6.34
					260	38.44	55.33	6.23	57	70	3.10	42	58	32.39	41.12	26.49	6.78
23	35.28	50.21	14.51	5.38	261	37.65	55.89	6.46	55	70	3.43	36	57	29.05	37.11	33.84	8.51
					262	37.33	52.95	9.72	33	58	4.15	23	51	28.82	40.94	30.24	10.40
					263	37.85	54.22	7.93	45	58	3.86	28	45	25.75	36.64	37.61	9.24
20	30.49	52.77	16.74	.47	264	32.43	53.21	14.36	14	34	.58	....	4	21.38	22.65	55.97	.71
					265	31.36	54.84	13.80	18	37	.57	....	9	No sample.			
					266	32.68	55.52	11.80	30	55	.56	....	23	23.64	30.85	45.51	.42
					267	38.37	52.04	9.59	34	48	.73	13	32	27.33	36.69	35.98	.55
25	36.35	49.21	14.44	.84	268	38.49	50.75	10.76	25	47	.75	11	36	.....	.....	30.72	.69
					269	36.32	51.83	11.85	18	38	.84	....	25	28.69	40.15	31.16	.94
27	33.80	52.44	13.76	.67	271	33.71	55.61	10.68	22	38	.62	7	25	28.22	41.72	30.06	.81
28	37.15	49.40	13.45	.63	272	36.24	54.65	9.11	32	41	.61	3	16	28.66	34.57	36.77	.85
30	22.98	64.84	12.18	.42	273	24.55	66.14	9.31	24	35	.46	....	7	22.44	50.54	27.02	.52
29	23.39	67.16	9.45	.65	274	23.34	70.17	6.49	31	40	.52	20	31	23.48	62.60	13.92	.94
29 30	23.18	66.01	10.81	.53	275	23.79	68.23	7.98	26	37	.48	9	23	21.57	55.51	22.92	.74
24	20.13	25.96	53.91	.42	276	23.79	42.10	34.11	37	81	.46	....	67	20.35	31.14	58.51	.53
					277	25.34	40.59	34.07	37	84	.49	....	71	18.45	23.27	58.28	.74
32	39.32	49.16	11.52	1.63	278	40.86	50.97	8.17	29	38	1.54	6	17	30.08	37.47	32.45	1.54
31	38.33	46.50	15.17	.81	279	40.93	48.98	10.09	33	43	.82	....	12	24.96	25.86	49.18	1.48
33	42.11	52.87	5.02	1.19	280	42.38	53.43	4.19	16	22	.90	24	29	27.87	31.57	40.56	3.26

Raw-coal float-and-sink tests.

Denver No.	Test No.	Maximum size of coal.	Specific gravity of solution used.	Percentage of—		Float-coal analyses (dry basis).	
				Float.	Sink.	Ash.	Sulphur.
15A	1	2 inches	1.35	73	27	6.01	1.05
	2	...do..	1.45	96	4	9.07	.92
	3	1 inch.	1.35	77	23	5.56	.93
	4	...do..	1.45	94	6	7.35	.91
15B	5	Slack.	1.36	85	15	5.64	.99
	6	...do..	1.45	87	13	6.19	1.01
17	7	½ inch.	1.35	48	52	7.20	.67
	8	...do..	1.45	78	22	12.03	.71
16	9	...do..	1.35	68	32	6.98	.68
	10	...do..	1.45	86	14	9.36	.66
	11	¾ inch.	1.35	65	35	8.29	.74
	12	...do..	1.45	84	16	11.62	.66
18	13	...do..	1.35	73	27	8.03	.58
	14	...do..	1.45	81	19	10.00	.54
	15	⅜ inch.	1.35	78	22	10.54	.60
	16	...do..	1.45	87	13	11.18	.56
19A	33	...do..	1.35	51	49	6.63	.77
	34	...do..	1.40	59	41	8.19	.77
	35	...do..	1.45	70	30	9.68	.81
	36	...do..	1.54	76	24	12.52	.72
	41	¾ inch.	1.35	46	54	6.66	.72
	42	...do..	1.40	56	44	10.02	.68
	43	...do..	1.45	68	32	10.20	.71
	44	...do..	1.54	74	26	13.21	.71
19C	37	⅜ inch.	1.35	67	33	6.13	.77
	38	...do..	1.40	75	25	7.23	.78
	39	...do..	1.45	81	19	8.07	.71
	40	...do..	1.55	82	18	9.12	.78
22	117	...do..	1.34	16	84	5.95	2.34
	118	...do..	1.40	23	77	7.83	2.41
	119	...do..	1.46	27	73	9.52	2.48
	120	...do..	1.52	33	67	10.06	2.59
	121	¾ inch.	1.35	24	76	6.99	2.34
	122	...do..	1.40	33	67	7.93	2.52
	123	...do..	1.46	40	60	9.10	2.52
	124	...do..	1.51	45	55	9.30	2.62
21B	157	...do..	1.34	83	17	7.98	.47
	158	...do..	1.40	90	10	8.98	.46
	159	...do..	1.45	91	9	8.47	.49
	160	...do..	1.54	91	9	9.25	.40
23	161	⅜ inch.	1.34	85	15	7.43	.45
	162	...do..	1.40	90	10	8.11	.56
	163	...do..	1.45	93	7	8.38	.48
	164	...do..	1.54	95	5	9.18	.57
	149	¾ inch.	1.35	73	27	5.01	2.75
	150	...do..	1.40	80	20	6.80	3.00
	151	...do..	1.45	80	20	6.81	3.15
	152	...do..	1.54	88	12	7.31	3.47
	153	⅜ inch.	1.35	73	27	3.78	2.34
	154	...do..	1.41	82	18	4.43	2.65
	155	...do..	1.45	83	17	5.17	2.76
	156	...do..	1.54	87	13	5.30	3.03
24	185	(a)	1.35	7	93	7.86	0.75
	186	(a)	1.42	15	85	10.26	.62
	187	(a)	1.46	18	82	12.39	.61
	188	(a)	1.55	25	75	14.72	.55
25	197	1 inch.	1.35	70	30	6.18	.69
	198	...do..	1.40	80	20	7.19	.68
	199	...do..	1.46	85	15	8.14	.66
	200	...do..	1.55	88	12	8.40	.64
24	201	⅜ inch.	1.35	8	92	8.78	.62
	202	...do..	1.40	10	90	9.94	.50
	203	...do..	1.46	20	80	12.15	.63
	204	...do..	1.55	24	76	17.16	.60
28	221	...do..	1.35	68	32	6.21	.60
	222	...do..	1.40	85	15	7.56	.57
	223	...do..	1.46	86	14	8.90	.64
	224	...do..	1.55	91	9	9.61	.64
20	173	...do..	1.35	45	55	7.18	.46
	174	...do..	1.41	60	40	8.81	.51
	175	...do..	1.45	66	34	9.54	.48
	176	...do..	1.54	76	24	10.47	.51
27	229	...do..	1.35	65	35	8.22	.65
	230	...do..	1.40	87	13	9.33	.65
	231	...do..	1.46	90	10	10.12	.63
	232	...do..	1.55	95	5	10.47	.56
30	233	...do..	1.35	77	23	6.79	.46
	234	...do..	1.40	77	23	7.66	.46
	235	...do..	1.46	90	10	8.54	.44
	236	...do..	1.55	92	8	9.32	.47
29	253	...do..	1.35	86	14	6.38	.48
	254	...do..	1.40	92	8	5.88	.52
	255	...do..	1.46	92	8	6.54	.52
	256	...do..	1.55	92	8	7.70	.48
29	257	...do..	1.35	81	19	7.36	.45
	258	...do..	1.40	85	15	6.47	.47
30	259	...do..	1.46	85	15	7.69	.45
	260	...do..	1.55	92	8	8.34	.44
24	269	⅜ inch.	1.35	29	71	5.91	.53
	270	...do..	1.40	42	58	6.89	.56
	271	...do..	1.46	50	50	7.98	.57
	272	...do..	1.55	53	47	11.70	.54
32	277	¾ inch.	1.35	76	24	4.42	1.47
	278	...do..	1.40	84	16	5.75	1.54
	279	...do..	1.46	93	7	7.53	1.53
	280	...do..	1.55	93	7	7.05	1.63
31	281	...do..	1.35	64	36	5.83	.75
	282	...do..	1.40	73	27	6.35	.81
	283	...do..	1.46	80	20	8.20	.75
	284	...do..	1.55	84	14	8.62	.81
33	293	...do..	1.35	93	7	2.20	.89
	294	...do..	1.40	95	5	2.55	1.00
	295	...do..	1.46	93	7	2.98	.98
	296	...do..	1.55	98	2	3.69	.97

[a] As received.

Refuse float-and-sink tests.

Denver No.	Refuse from washing test No.	Test No.	Specific gravity of solution used.	Percentage of—		Float-coal analyses (dry basis).	
				Float.	Sink.	Ash.	Sulphur.
15A	232	17	1.37	69	31	7.00	1.08
		18	1.41	79	21	8.20	1.18
		19	1.47	88	12	11.09	1.08
		20	1.58	90	10	12.03	1.24
	233	25	1.35	66	34	6.94	1.08
		26	1.40	71	29	8.85	1.23
		27	1.45	78	22	9.91	1.05
		28	1.54	85	15	13.02	1.08
	234	21	1.35	60	40	6.07	1.06
		22	1.40	65	35	7.88	.98
		23	1.45	67	33	8.65	1.04
		24	1.54	75	25	12.25	1.04
	235	29	1.35	37	63	6.75	.95
		30	1.40	44	56	9.57	1.02
		31	1.45	59	41	10.33	.07
		32	1.54	57	43	13.75	1.08
15B	236	45	1.32	33	67	5.00	.92
		46	1.40	33	67	5.09	.99
		47	1.45	41	59	7.42	1.11
		48	1.54	50	50	9.92	1.42
17	237	61	1.35	26	74	7.41	.84
		62	1.40	41	59	10.21	.78
		63	1.46	57	43	12.26	.70
		64	1.55	66	34	13.58	.72
15B	238	49	1.32	3	97	Destroyed.	
		50	1.40	5	95	8.39	.90
		51	1.45	7	93	10.34	1.07
		52	1.54	7	93	13.45	1.06
	239	53	1.32	20	80	4.89	.91
		54	1.40	30	70	6.28	.96
		55	1.45	36	64	7.36	1.04
		56	1.54	36	64	8.57	1.03
	240	57	1.32	12	88	4.96	1.02
		58	1.40	18	82	7.57	1.03
		59	1.45	22	78	7.32	1.06
		60	1.54	23	77	9.67	1.06
17	241	65	1.35	20	80	6.99	.65
		66	1.40	38	62	11.13	.73
		67	1.46	43	57	14.44	.77
		68	1.55	50	50	17.50	.53
16	242	69	1.35	16	84	6.65	.64
		70	1.40	30	70	11.77	.67
		71	1.46	39	61	14.46	.69
		72	1.55	56	44	18.15	.62
18	243	73	1.35	24	76	7.97	.61
		74	1.40	31	69	12.84	.57
		75	1.46	47	53	12.44	.69
		76	1.55	50	50	15.84	.52
17	244	77	1.35	21	79	9.55	.90
		78	1.40	38	62	12.92	.70
		79	1.46	51	49	14.18	.63
		80	1.55	65	35	17.99	.60
18	245	81	1.35	13	87	9.78	.55
		82	1.40	20	80	12.04	.42
		83	1.46	24	76	14.74	.63
		84	1.55	33	67	18.78	.45
	246	85	1.35	41	59	7.96	.08
		86	1.40	48	52	10.30	.58
		87	1.46	56	44	11.79	.54
		88	1.55	63	37	13.02	.51
16	247	89	1.35	30	70	6.26	.65
		90	1.40	50	50	8.64	.67
		91	1.46	60	40	11.24	.62
		92	1.55	69	31	11.95	.54
18	248	93	1.35	19	81	7.91	.55
		94	1.40	26	74	11.76	.54
		95	1.46	42	58	13.67	.51
		96	1.55	53	47	16.18	.51
16	249	97	1.35	29	71	6.02	.56
		98	1.40	47	53	8.27	.72
		99	1.46	61	39	10.98	.64
		100	1.54	70	30	14.45	.95
19A	250	101	1.35	18	82	7.25	.75
		102	1.40	29	71	9.98	.77
		103	1.46	41	59	13.03	.74
		104	1.54	51	49	15.83	.69
19A	251	105	1.35	14	86	7.74	0.68
		106	1.40	25	75	11.44	.72
		107	1.46	31	69	13.94	.71
		108	1.54	43	57	17.11	.65
	252	109	1.35	20	80	8.32	.71
		110	1.40	31	69	10.63	.73
		111	1.46	44	56	13.67	.81
		112	1.54	53	47	14.76	.68
19C	253	113	1.35	38	62	7.02	.50
		114	1.40	6	54	8.56	.57
		115	1.46	54	46	12.68	.73
		116	1.54	58	42	11.30	.76
22	254	125	1.34	6	94	6.59	2.03
		126	1.41	11	89	9.54	2.29
		127	1.45	12	88	16.12	2.37
		128	1.51	14	86	16.92	2.66
	255	129	1.34	6	94	5.63	2.28
		130	1.41	11	89	8.12	2.33
		131	1.45	14	86	9.27	2.75
		132	1.51	15	85	10.91	3.60
21A	256	133	1.35	11	89	9.94	1.13
		134	1.40	18	82	9.96	1.06
		135	1.45	22	78	10.60	1.12
		136	1.54	27	73	15.72	.93
21B	257	137	1.35	35	65	7.29	.47
		138	1.40	48	52	8.71	.57
		139	1.45	46	54	9.95	.50
		140	1.55	55	45	12.53	.53
	258	141	1.35	53	47	7.76	.39
		142	1.40	59	41	8.64	.42
		143	1.45	61	39	9.64	.37
		144	1.55	68	32	10.77	.44
	259	145	1.35	40	60	5.94	2.25
		146	1.40	46	54	7.39	2.30
		147	1.45	57	43	8.82	2.62
		148	1.55	58	42	9.42	3.90
23	260	165	1.35	36	64	5.85	2.60
		166	1.40	48	52	7.33	3.25
		167	1.45	58	42	7.24	3.37
		168	1.55	58	42	8.83	4.32
	261	169	1.35	31	69	5.47	3.13
		170	1.41	52	48	6.83	3.82
		171	1.45	46	54	8.88	4.50
		172	1.54	59	41	9.50	5.04
	262	177	1.35	50	50	4.37	2.47
		178	1.40	58	42	6.23	3.19
		179	1.45	64	36	6.34	3.16
		180	1.54	68	32	7.60	3.57
	263	181	1.35	33	67	5.60	2.86
		182	1.40	40	60	6.21	3.28
		183	1.45	42	58	7.97	4.03
		184	1.54	44	56	7.73	4.05
20	264	189	1.35	4	96	7.98	1.06
		190	1.42	11	89	8.46	.87
		191	1.46	13	87	9.97	.93
		192	1.55	20	80	14.00	.84
	265	193	1.35	8	92	6.20	.90
		194	1.42	11	89	9.81	.89
		195	1.46	15	85	9.09	.93
		196	1.55	16	84	15.28	.72
	266	205	1.35	16	84	7.73	.48
		206	1.40	19	81	10.53	.69
		207	1.46	28	72	12.26	.54
		208	1.55	32	68	16.39	.56
	267	209	1.35	21	79	6.39	.67
		210	1.40	30	70	8.89	.67
		211	1.46	39	61	11.09	.66
		212	1.55	51	49	14.89	.64
25	268	213	1.35	32	68	6.98	.69
		214	1.40	41	59	7.31	.63
		215	1.46	53	47	9.06	.69
		216	1.55	63	37	13.75	.66
	269	217	1.35	38	62	6.33	.63
		218	1.40	53	47	8.20	.69
		219	1.46	62	38	9.74	.69
		220	1.55	69	31	11.54	.69

Refuse float-and-sink tests—Continued.

Denver No.	Refuse from washing test No.	Test No.	Specific gravity of solution used.	Percentage of—		Float-coal analyses (dry basis).	
				Float.	Sink.	Ash.	Sulphur.
21B	270	225	1.35	53	47	8.11	0.57
		226	1.40	60	40	9.27	.51
		227	1.46	65	35	9.74	.50
		228	1.55	70	30	11.36	.53
27	271	237	1.35	32	68	7.50	.66
		238	1.40	44	56	10.22	.58
		239	1.46	56	44	12.82	.64
		240	1.55	63	37	16.28	.61
28	272	241	1.35	20	80	6.65	.66
		242	1.40	27	73	10.40	.59
		243	1.46	43	57	12.41	.58
		244	1.55	61	39	17.57	.56
30	273	245	1.35	26	74	8.26	.46
		246	1.40	34	66	9.43	.46
		247	1.46	42	58	11.93	.48
		248	1.55	51	49	15.26	.42
29	274	249	1.35	52	48	5.34	.48
		250	1.40	62	38	7.13	.51
		251	1.46	67	33	7.97	.47
		252	1.55	78	22	9.87	.46
29	275	265	1.35	34	66	6.62	.50
30		266	1.40	42	58	8.70	.42
		267	1.46	46	54	8.85	.46
		268	1.55	60	40	14.86	.61
24	276	261	1.35	13	87	5.96	0.59
		262	1.40	21	79	7.90	.56
		263	1.46	23	77	10.86	.57
		264	1.55	31	69	13.87	.56
	277	273	1.35	7	93	7.51	.59
		274	1.40	10	90	10.04	.63
		275	1.46	16	84	12.24	.57
		276	1.55	17	83	17.72	.52
32	278	285	1.35	18	82	4.73	1.41
		286	1.40	30	70	7.15	1.28
		287	1.46	33	67	7.89	1.28
		288	1.55	45	55	11.78	1.69
31	279	289	1.35	13	87	4.99	.81
		290	1.40	16	84	8.25	.80
		291	1.46	16	84	9.83	1.00
		292	1.55	25	75	12.05	.94
33	280	297	1.35	30	70	4.02	.93
		298	1.40	38	62	5.26	.91
		299	1.46	43	57	5.59	1.04
		300	1.55	43	57	8.88	.94

Raw-coal screening tests.[a]

Denver No.	Percentage of coal passing screen.							Denver No.	Percentage of coal passing screen.						
	Over 1¼-inch.	Through 1¼-inch and over 1-inch.	Through 1-inch and over ¾-inch.	Through ¾-inch and over ½-inch.	Through ½-inch and over ⅜-inch.	Through ⅜-inch and over ¼-inch.	Through ¼-inch.		Over 1¼-inch.	Through 1¼-inch and over 1-inch.	Through 1-inch and over ¾-inch.	Through ¾-inch and over ½-inch.	Through ½-inch and over ⅜-inch.	Through ⅜-inch and over ¼-inch.	Through ¼-inch.
15A	3	7	22	23	12	11	22	[b]23	.....	.....	.....	.....	3	10	87
15B	7	7	8	16	9	11	42	31	.....	16	18	18	9	14	25
17	.....	3	19	19	6	12	41	32	.....	35	24	19	8	6	8
16	.....	3	10	22	12	19	34	33	.....	17	20	28	8	10	17
[b]17	.....	.....	.....	1	1	12	86	20	.....	.....	2	14	7	21	56
18	.....	.....	3	5	5	17	70	25	.....	.....	3	15	10	17	55
19A	.....	2	12	21	9	16	40	27	.....	3	15	32	11	15	24
[b]19C	.....	.....	.....	.....	.....	3	97	28	.....	6	14	20	9	17	34
21A	.....	5	11	26	11	13	34	29	.....	2	13	22	7	13	43
22	.....	.....	.....	3	3	6	88	30	.....	2	9	21	7	14	47
23	.....	11	15	19	7	11	37								

[a] These tests show the result of screening after the samples had been passed through a 24 by 30 inch corrugated-roll disintegrator (three-fourths inch between the rolls), or, for the three tests indicated, through a Pennsylvania hammer crusher.

[b] Hammer crusher.

NOTES ON TESTS.

Denver No. 15A is an Illinois run-of-mine coal of good quality. Four tests were made, the percentage of refuse varying from 8 to 25 per cent, the loss of coal increasing greatly as the percentage of refuse was increased, while the washed-coal analysis remained about the same for all tests, indicating no gain in a separation giving over 8 per cent refuse. The washing tests compare favorably with the raw-coal float-and-sink tests.

Denver No. 15B is a slack coal from the same Illinois mine and, as will be noted, carried a higher percentage of ash. One test was made on the special jig and three on the Richards. The special-jig test gave better results, but the loss of coal was higher than in those made on the Richards jig. The refuse from the Richards jig was very free from coal, but on account of the then existing shape of the refuse gates it was not possible to attain so high a percentage of refuse as was desired from this machine in these tests. The shape of these gates was changed after the tests on this coal were made, and thereafter they permitted a higher percentage of refuse to be discharged. Test 236 on the special jig compared favorably with the raw-coal float-and-sink tests. The others were not so good.

Denver No. 16 is from the Sopris mine (Sopris, Colo.), and may be compared with that from the Francisco mine (Sopris, Colo.), which was tested the previous year under the designation Denver No. 7. Comparison of the tests on these two coals shows that the analyses of the resulting washed coals were about the same and the coal loss was high in both. The tests on the Richards jig were not quite so good as the one made on the special jig, and this test compares very well with the raw-coal float-and-sink tests.

For Denver No. 17 the test on the special jig was the most satisfactory and compares well with the float-and-sink tests. The Richards jig tests gave a cleaner refuse, but not enough of it.

For Denver No. 18 the tests on the special jig were good and compare favorably with the float-and-sink tests, though the coal loss is a little too high. Test 245 on the Richards jig was very good and the coal loss low.

The ash reduction of the tests on Denver No. 19A does not compare very well with that of the float-and-sink tests and the coal losses are all very high. Forty per cent of the coal as washed, however, passed through a $\frac{1}{4}$-inch mesh screen, and more careful washing will probably show much better results.

In Denver No. 19C there was only sufficient coal for one test, and this one did not give satisfactory results when compared with the float-and-sink tests.

The test on Denver No. 21A was quite satisfactory in all respects.

On Denver No. 21B special-jig tests gave best results, though the float-and-sink tests would indicate that a little better separation is possible.

Denver No. 22 is a very high ash coal from Montana, the raw coal analyzing 38.97 per cent ash and 7.93 per cent sulphur, as against an analysis of 32.19 per cent ash and 0.54 per cent sulphur for the Montana coal tested last year (Denver No. 5). However, the tests made on the special jig on Denver No. 22 were much better than those of last year on Denver No. 5; in fact, test 255 is very

satisfactory. The loss of coal is high, but in view of the fact that over 50 per cent of the run-of-mine coal must be discarded as refuse to reduce the ash as desired this coal loss is not bad, for the coal was very fine and very hard to handle in the washer plant. It will be noted, by referring to the table of screening tests, that 88 per cent of this run-of-mine coal passed through a ¼-inch mesh screen.

The tests on Denver No. 23, except the one made on the Richards jig, are very good, although the coal losses were very high; otherwise they compare favorably with the float-and-sink tests. With a much longer sludge-recovery tank the loss of coal could be brought down to a more reasonable figure.

The tests on Denver No. 20 compare fairly well with the float-and-sink tests, though they could be slightly improved with more careful jig adjustment.

The tests on Denver No. 25 are fair, but, like those on Denver No. 20, could be improved.

Of all the other coals tested and not yet mentioned, but one test was made on each; nothing need be added to the results in the tables.

Denver No. 24 is a refuse from one of the washeries of the Trinidad district. A few tests were made on it with the view of determining the possibility of the use of the Richards jig as it now stands for rewashing; but the tests were not satisfactory, as will be noted from the results appearing in the tables.

COKING TESTS.

By A. W. Belden.

EQUIPMENT.

The equipment of the coking section proved so satisfactory in the previous tests that no change was deemed necessary. The equipment included a battery of two beehive ovens (one 7 feet high by 12 feet in diameter, the other 6 feet 3 inches high by 12 feet in diameter), a standard larry of 8 tons capacity, and the necessary scales for accurate weighing of coal charged and coke produced.

PROCEDURE OF TESTS.

All coal was finely crushed through a Pennsylvania hammer crusher, except as otherwise noted in the detailed report of the tests. The proportionate sizes of the coal after being put through the hammer crusher varied somewhat, depending on the friability of the coal, but the average, taken from a large number of samples, showed

practically the same as in former work, as follows: Through $\frac{1}{8}$-inch mesh, 100 per cent; over 10-mesh, 31.43 per cent; over 20-mesh, 24.29 per cent; over 40-mesh, 22.86 per cent; over 60-mesh, 11.42 per cent; through 60-mesh, 10 per cent. The sampling of coal and coke and the handling of the ovens were practically the same as described in Bulletin 336 of the United States Geological Survey, from which the following paragraphs are quoted:

Both the door and the trunnel head of the oven were always closed directly after the oven was drawn and it was allowed to gather heat, the length of time varying as necessity demanded. The average time was one and one-half hours.

The sample of coal was taken at regular intervals, as the charge was emptied from bin to larry, by means of a small shovel holding about one-fourth pound. The total weight of the sample averaged 45 pounds.

The sample of coke was taken from five different parts of the oven, as nearly as possible from the same location for each test, as follows: 2 feet from the oven door; 2 feet from each side, on a line drawn from the center of the oven; at the center; and 2 feet from the back wall, on a line with the point of selection of the pieces taken from the door and the center. The separate pieces of coke extended the whole height of the charge and were as nearly uniform in size as possible.

NUMBER OF TESTS.

From August 21, 1908, to January 2, 1909, 69 tests were made on 22 coals from five States and one Territory, as shown in the following tables. Of these tests, 12 were made on raw coal, 55 on washed coal, and 2 on mixtures of washed coals. Of the 22 different coals, five (Nos. 19, 26, 28, 32, and 33) produced no coke, whether tested raw or washed, crushed or not crushed.

TABULATED RESULTS.

The results of the coking tests will be found in the detailed reports on the several samples presented herewith. The method hitherto used to state all the items, so as to show the yield of dry coke from dry coal, the coke as received from coal as charged, etc., has been continued. The percentage of coke remaining on a screen with 2-inch mesh, after four consecutive 6-foot drops without intermediate screening, as well as the percentage after each drop, is given in the last item under "Physical properties of coke." The first four items represent the percentage from each separate drop with all material less than 2-inch screened out, the fifth item the percentage after four consecutive drops, all material being returned each time. It was decided to make the phosphorus determination on each coke produced in order that a better average might be obtained. "Cell structure" refers to the general appearance as to size and not to the number of cells as given by percentage of cells by volume. In many tests in which the cell structure as determined from general

appearance is small the percentage of cells by volume is quite the reverse. The following abbreviations are used in the tables:

scr., screenings.
f. c., finely crushed.
n. c., not crushed.
r., raw.
r. o. m., run of mine.
sl., slack.
w., washed.

DENVER No. 15A.

Coking tests.

	Test—				
	247.	248.	249.	250.	251.
Date	8,24,08	8,28,08	8,31,08	9,1,08	9,2,08
Duration....hours..	48	52	57	60	57
Size:					
As shipped	r. o. m.	r. o. m.	r. o. m.	r. o. m.	r. o. m.
As used	r., f. c.	w., f. c.	w., f. c.	w., f. c.	w., f. c.
Coal charged:					
Wet....pounds..	11,730	11,000	11,800	12,200	12,850
Dry....do....	10,833	9,903	10,651	11,551	11,664
Coke produced:					
Wet....do....	7,200	6,229	6,302	6,664	7,496
Wet....per cent..	61.38	56.63	53.40	54.62	58.33
Dry....pounds...	7,019	6,165	6,264	6,620	7,458
Dry....per cent..	64.79	62.25	58.81	57.31	63.94
Breeze produced:					
Wet....pounds...	400	438	389	458	512
Wet....per cent..	3.41	3.98	3.30	3.75	3.99
Dry....pounds...	390	434	387	455	509
Dry....per cent..	3.60	4.38	3.63	3.94	4.36
Total yield:					
Wet....do....	64.79	60.61	56.70	58.37	62.32
Dry....do....	68.39	66.63	62.44	61.25	68.30
Physical properties of coke:					
Specific gravity—					
Apparent	0.83	0.76	0.77	0.78	0.82
Real	1.82	1.78	1.77	1.79	1.79
Volume—					
Coke....per cent..	46.00	43.00	44.00	44.00	46.00
Cells....do....	54.00	57.00	56.00	56.00	54.00
Weight per cubic foot—					
Wet....pounds..	84.16	82.45	82.64	83.29	84.54
Dry....do....	50.48	46.90	47.70	48.35	50.86
6-foot drop test over 2-inch mesh—					
1....per cent..	98.00	98.00	98.50	98.50	98.00
2....do....	93.00	95.50	98.00	98.00	95.50
3....do....	89.50	92.00	94.00	95.50	92.00
4....do....	85.50	89.50	91.50	91.00	89.00
5....do....	89.00	92.00	90.00	92.50	91.50

Remarks.—Test 247: Light gray and silvery. Breakage good; long, large pieces. Cell structure good. Metallic ring. Good, strong coke.

Test 248: Light gray, some little silvery deposit of carbon. Somewhat fingered. One-inch layer of black, soft coke on bottom of oven, due to hot bottom. Cell structure good. Metallic ring.

Test 249: Light gray and silvery. Cell structure good. Breakage somewhat fingered, but pieces of good uniform size. Metallic ring.

Test 250: Light gray, some little silvery deposit of carbon. Breakage same as test 249. Metallic ring. Good coke.

Test 251: Light gray and silvery. Cell structure good. Breakage same as test 249. Metallic ring. Good coke. Washing of this coal results in change of coke from good, long, large pieces to somewhat fingered condition.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
247	482-D...	Coal	Wet..	7.65	33.97	49.60	8.78	0.91	.....
			Dry..	.....	36.78	53.71	9.51	.99	.....
	487-D...	Coke	Wet..	2.52	2.20	79.63	15.65	.86	0.0203
			Dry..	.....	2.26	81.68	16.06	.88	.....
248	492-D...	Coal	Wet..	9.97	34.82	48.70	6.51	1.01	.....
			Dry..	.....	38.68	54.09	7.23	1.12	.....
	498-D...	Coke	Wet..	1.02	1.58	87.38	10.02	.80	.0165
			Dry..	.....	1.60	88.28	10.12	.82	.....
249	496-D...	Coal	Wet..	9.74	34.70	49.35	6.21	.97	.....
			Dry..	.....	38.45	54.67	6.88	1.08	.....
	500-D...	Coke	Wet..	.61	1.79	86.77	10.83	.81	.0173
			Dry..	.....	1.80	87.31	10.89	.82	.....
250	497-D...	Coal	Wet..	5.32	38.43	49.42	6.83	1.02	.....
			Dry..	.....	40.60	52.19	7.21	1.08	.....
	504-D...	Coke	Wet..	.66	1.76	86.44	11.14	.71	.0152
			Dry..	.....	1.77	87.01	11.22	.72	.....
251	499-D...	Coal	Wet..	9.23	35.64	48.30	6.83	1.00	.....
			Dry..	.....	39.25	53.23	7.52	1.10	.....
	507-D...	Coke	Wet..	.51	1.80	87.17	10.52	.78	.0166
			Dry..	.....	1.81	87.61	10.58	.78	.....

DENVER No. 15B.

Coking tests.

	Test—			
	252.	254.	256.	258.
Date	9,3,08	9,6,08	9,12,08	9,14,08
Duration, hours	55	52	66	51
Size:				
As shipped	scr.	scr.	scr.	scr.
As used	w., f. c.	w., f. c.	w., f. c.	w., f. c.
Coal charged:				
Wet, pounds	11,980	11,190	12,220	11,630
Dry, do	10,638	8,739	10,300	10,724
Coke produced:				
Wet, do	6,068	5,234	5,940	6,600
Wet, per cent	50.65	46.77	48.61	56.75
Dry, pounds	6,035	5,153	5,805	6,584
Dry, per cent	56.73	58.97	56.36	61.40
Breeze produced:				
Wet, pounds	359	414	510	350
Wet, per cent	3.00	3.70	4.17	3.01
Dry, pounds	357	408	498	349
Dry, per cent	3.36	4.67	4.84	3.25
Total yield:				
Wet, do	53.65	50.47	52.78	59.76
Dry, do	60.09	63.64	61.20	64.65
Physical properties of coke:				
Specific gravity—				
Apparent	0.81	0.77	0.81	0.86
Real	1.78	1.80	1.79	1.80
Volume—				
Coke, per cent	46.00	43.00	45.00	48.00
Cells, do	54.00	57.00	55.00	52.00
Weight per cubic foot—				
Wet, pounds	83.93	82.83	83.67	85.95
Dry, do	50.25	47.28	49.38	53.53
6-foot drop test over 2-inch mesh—				
1, per cent	98.00	98.00	98.50	98.50
2, do	96.50	94.50	95.00	98.00
3, do	95.00	93.00	92.50	94.00
4, do	90.00	90.00	91.00	91.50
5, do	93.00	91.50	91.50	95.50

Remarks.—Test 252: Light gray and silvery. Cell structure good. Breakage somewhat fingered, but pieces of good uniform size. Metallic ring. Good coke.

Test 254: Light gray with large deposit of carbon. Breakage, good; long, large, uniform-sized pieces, same as from test 247, Denver 15A, raw coal. Probably due to ash in coal not reduced so low as in other washed coal. Metallic ring. Good coke.

Test 256: Light gray and silvery. Cell structure good. Breakage somewhat fingered, but pieces of good, uniform size. Metallic ring. One-half inch black butts accounts for high volatile in coke.

Test 258: Light gray and silvery. Cell structure good. Somewhat fingered, but pieces of good uniform size. Metallic ring. Good coke.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
252	503–D...	Coal	Wet..	11.19	35.11	47.27	6.43	0.97	.....
			Dry..	.....	39.53	53.23	7.24	1.09	.....
	508–D...	Coke	Wet..	.55	1.40	87.44	10.61	.80	0.0170
			Dry..	.....	1.41	87.91	10.68	.80	.....
254	506–D...	Coal	Wet..	21.01	29.31	41.54	8.14	.90	.....
			Dry..	.....	37.10	52.59	10.31	1.14	.....
	517–D...	Coke	Wet..	1.54	2.14	80.55	15.77	.93	.0206
			Dry..	.....	2.17	81.81	16.02	.95	.....
256	516–D...	Coal	Wet..	14.89	31.95	45.73	7.43	.87	.....
			Dry..	.....	37.55	53.72	8.73	1.02	.....
	534–D...	Coke	Wet..	2.27	4.81	78.73	14.19	1.04	.0198
			Dry..	.....	4.92	80.56	14.52	1.06	.....
258	535–D...	Coal	Wet..	7.79	32.56	50.35	9.30	.91	.....
			Dry..	.....	35.31	54.60	10.09	.99	.....
	542–D...	Coke	Wet..	.24	1.20	82.70	15.86	.81	.0146
			Dry..	.....	1.20	82.90	15.90	.81	.....

DENVER No. 16.

Coking tests.

	Test—				
	259.	260.	266.	268.	271.
Date	9,17,08	9,18,08	9,26,08	9,30,08	10,5,08
Duration, hours	45	49	56	50	72
Size:					
As shipped	r. o. m.	r. o. m.	r. o. m.	r. o. m.	r. o. m.
As used	w., f. c.	w., f. c.	w., f. c.	w., f. c.	w., f. c.
Coal charged:					
Wet, pounds	11,630	13,630	14,760	11,870	15,150
Dry, do	11,139	12,782	13,139	10,688	13,668
Coke produced:					
Wet, do	8,100	8,550	9,300	7,500	9,669
Wet, per cent	69.65	62.73	63.01	63.19	63.82
Dry, pounds	8,081	8,467	9,282	7,488	9,621
Dry, per cent	72.55	66.24	70.65	70.06	70.39
Breeze produced:					
Wet, pounds	269	300	284	237	340
Wet, per cent	2.31	2.20	1.92	1.99	2.24
Dry, pounds	268	297	283	237	338
Dry, per cent	2.41	2.32	2.15	2.22	2.47
Total yield:					
Wet, do	71.96	64.93	64.93	65.18	66.06
Dry, do	74.96	68.56	72.80	72.28	72.86
Physical properties of coke:					
Specific gravity—					
Apparent	1.03	1.09	1.09	1.07	1.08
Real	1.88	1.92	1.89	1.93	1.90
Volume—					
Coke, per cent	55.00	57.00	52.00	55.00	57.00
Cells, do	45.00	43.00	48.00	45.00	43.00
Weight per cubic foot—					
Wet, pounds	92.16	94.15	97.80	94.72	93.84
Dry, do	64.08	67.32	67.86	66.64	67.02
6-foot drop test over 2-inch mesh—					
1, per cent	96.00	96.00	99.60	98.00	98.50
2, do	94.50	95.50	97.00	96.50	96.50
3, do	93.00	93.00	95.50	94.00	95.00
4, do	91.50	90.50	93.50	91.50	91.50
5, do	93.50	93.50	94.00	92.00	93.50

Remarks.—Test 259: Light gray and silvery. Breakage good, large pieces. Cell structure small. Good, hard, strong coke.

Test 260: Light gray and silvery. Breakage, good-sized pieces, somewhat cross fractured, but uniform. Cell structure small. Good, strong, hard coke.

Test 266: Light gray and silvery. Breakage somewhat irregular, but pieces of good, large, uniform size. Cell structure small, dense. Good, hard, strong, heavy coke.

Test 268: Light gray and silvery. Breakage irregular, but pieces of good, large, uniform size. Cell structure small, dense. Good, strong, hard coke.

Test 271: Light gray and silvery, large deposit of carbon. Breakage good, long, large pieces. Cell structure small, dense. Metallic ring. Good, strong, hard, heavy coke.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
259	540–D	Coal	Wet	4.22	29.95	54.56	11.27	0.62	.....
			Dry	.....	31.27	56.95	11.78	.65	.....
	544–D	Coke	Wet	.24	1.11	81.78	16.87	.58	0.0173
			Dry	.....	1.11	81.98	16.91	.58	.....
260	546–D	Coal	Wet	6.22	30.07	53.03	10.68	.66	.....
			Dry	.....	32.07	56.54	11.39	.70	.....
	548–D	Coke	Wet	.97	.92	81.75	16.36	.64	.0190
			Dry	.....	.93	82.55	16.52	.65	.....
266	555–D	Coal	Wet	10.98	28.33	49.65	11.04	.59	.....
			Dry	.....	31.82	55.78	12.40	.66	.....
	565–D	Coke	Wet	.19	.82	82.18	16.81	.52	.0296
			Dry	.....	.82	82.34	16.84	.52	.....
268	562–D	Coal	Wet	9.96	28.41	50.84	10.79	.62	.....
			Dry	.....	31.55	56.47	11.98	.69	.....
	590–D	Coke	Wet	.16	.96	81.82	17.06	.58	.0291
			Dry	.....	.96	81.95	17.09	.59	.....
271	589–D	Coal	Wet	9.78	27.84	51.27	11.11	.66	.....
			Dry	.....	30.85	56.84	12.31	.73	.....
	616–D	Coke	Wet	.50	1.12	81.87	16.51	.42	.0352
			Dry	.....	1.13	82.27	16.60	.42	.....

DENVER No. 17.

Coking tests.

	Test—			
	253.	255.	257.	261.
Date	9,5,08	9,8,08	9,13,08	9,20,08
Duration, hours	47	53	42	60
Size:				
As shipped	r. o. m.	r. o. m.	r. o. m.	r. o. m.
As used	w., f. c.	w., f. c.	w., f. c.	w., f. c.
Coal charged:				
Wet, pounds	11,920	12,220	11,200	13,700
Dry, do	11,279	11,196	10,489	12,805
Coke produced:				
Wet, do	7,650	7,650	6,840	8,850
Wet, per cent	64.18	62.60	61.07	64.60
Dry, pounds	7,617	7,522	6,806	8,800
Dry, per cent	67.53	67.18	64.89	68.72
Breeze produced:				
Wet, pounds	540	375	375	600
Wet, per cent	4.53	3.07	3.35	4.38
Dry, pounds	538	374	373	597
Dry, per cent	4.77	3.34	3.56	4.66
Total yield:				
Wet, per cent	68.71	65.67	64.42	68.98
Dry, do	72.30	70.52	68.45	73.38
Physical properties of coke:				
Specific gravity—				
Apparent	1.06	0.99	1.00	1.09
Real	1.93	1.89	1.91	1.94
Volume—				
Coke, per cent	55.00	52.00	52.00	56.00
Cells, do	45.00	48.00	48.00	44.00
Weight per cubic foot—				
Wet, pounds	93.92	91.48	91.97	95.02
Dry, do	65.84	61.53	62.03	67.59
6-foot drop test over 2-inch mesh—				
1, per cent	98.50	97.50	98.00	97.50
2, do	96.00	94.50	96.00	96.00
3, do	95.00	93.00	94.50	94.50
4, do	92.50	90.00	93.00	92.50
5, do	90.50	89.50	92.50	94.00

Remarks.—Test 253: Light gray, with some little deposit of carbon. Breakage somewhat cross-fractured, but pieces drawn in large chunks. Cell structure large. Soft coke.

Test 255: Light gray and silvery, large deposit of carbon. Breakage good, large, long pieces. Cell structure a little large. Metallic ring. Good, heavy coke.

Tests 257 and 261: Same as test 255.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
253	505–D...	Coal	Wet..	5.38	31.22	49.66	13.74	0.69	.....
			Dry..	.....	33.00	52.48	14.52	.73	.....
	509–D...	Coke	Wet..	.43	.94	77.98	20.65	.51	0.0198
			Dry..	.....	.94	78.32	20.74	.51	.....
255	510–D...	Coal	Wet..	8.38	32.28	48.98	10.36	.68	.....
			Dry..	.....	35.23	53.47	11.30	.74	.....
	515–D...	Coke	Wet..	.37	1.42	80.73	17.48	.57	.0142
			Dry..	.....	1.43	81.03	17.54	.57	.....
257	528–D...	Coal	Wet..	6.35	31.97	48.28	13.40	.65	.....
			Dry..	.....	34.14	51.54	14.32	.69	.....
	547–D...	Coke	Wet..	.49	.04	78.43	21.04	.62	.0145
			Dry..	.....	.04	78.82	21.14	.62	.....
261	541–D...	Coal	Wet..	6.53	31.05	48.42	14.00	.57	.....
			Dry..	.....	33.23	51.80	14.97	.61	.....
	549–D...	Coke	Wet..	.56	.16	77.50	21.78	.52	.0179
			Dry..	.....	.16	77.94	21.90	.52	.....

DENVER No. 18.

Coking tests.

	Test—				
	262.	263.	264.	265.	267.
Date	9,22,08	9,23,08	9,23,08	9,25,08	9,27,08
Duration.....hours..	63	33	39	34	54
Size:					
As shipped	r. o. m.	r. o. m.	r. o. m.	r. o. m.	r. o. m.
As used	w., f. c.	w., f. c.	w., f. c.	w., f. c.	w., f. c.
Coal charged:					
Wet.....pounds..	14,000	8,700	10,600	8,810	12,380
Dry.....do....	13,548	7,806	9,799	8,063	11,944
Coke produced:					
Wet.....do....	9,150	5,700	7,050	6,000	7,837
per cent..	65.35	65.52	66.51	68.10	63.30
Dry.....pounds...	9,144	5,667	7,017	5,998	7,824
per cent..	67.49	72.60	71.61	74.39	65.51
Breeze produced:					
Wet.....pounds...	264	175	249	197	300
per cent..	1.89	2.01	2.35	2.24	2.42
Dry.....pounds...	264	174	248	197	300
per cent..	1.95	2.23	2.53	2.44	2.51
Total yield:					
Wet.....do....	67.24	67.53	68.86	70.34	65.72
Dry.....do....	69.44	74.83	74.14	76.83	68.02
Physical properties of coke:					
Specific gravity—					
Apparent	1.11	1.03	1.10	1.08	1.08
Real	1.96	1.93	1.96	1.99	1.97
Volume—					
Coke.....per cent..	57.00	53.00	56.00	54.00	55.00
Cells.....do....	43.00	47.00	44.00	46.00	45.00
Weight per cubic foot—					
Wet.....pounds..	96.01	93.15	95.71	96.01	95.33
Dry.....do....	69.19	63.86	68.28	67.32	67.25
6-foot drop test over 2-inch mesh—					
1.....per cent..	98.00	98.50	98.00	97.50	98.50
2.....do....	96.00	96.00	95.50	96.00	97.00
3.....do....	94.50	94.50	94.00	94.50	95.00
4.....do....	92.50	92.50	92.50	91.50	93.50
5.....do....	94.00	93.50	94.50	94.00	95.50

Remarks.—Test 262: Light gray and silvery. Breakage good, long, large pieces. Cell structure small. Metallic ring. Good, strong, heavy coke.

Tests 263, 264, and 265: Same as 262.

Test 267: Light gray and silvery, large deposit of carbon. Breakage good, long, large, uniform-sized pieces. Cell structure small, dense. Metallic ring. Good, heavy, strong, hard coke.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
262	543–D...	Coal	Wet..	3.23	31.82	55.41	9.54	0.48	.....
			Dry..	.....	32.88	57.26	9.86	.50	.....
	558–D...	Coke	Wet..	.07	.86	84.72	14.35	.65	0.1333
			Dry..	.....	.86	84.78	14.36	.65	.....
263	554–D...	Coal	Wet..	10.28	29.53	51.64	8.55	.49	.....
			Dry..	.....	32.91	57.56	9.53	.55	.....
	559–D...	Coke	Wet..	.58	1.65	84.02	13.75	.51	.1226
			Dry..	.....	1.66	84.51	13.83	.51	.....
264	553–D...	Coal	Wet..	7.56	29.24	52.00	11.20	.49	.....
			Dry..	.....	31.63	56.26	12.11	.53	.....
	560–D...	Coke	Wet..	.47	1.35	79.80	18.38	.48	.1631
			Dry..	.....	1.35	80.19	18.46	.48	.....
265	556–D...	Coal	Wet..	8.48	28.51	51.43	11.58	.54	.....
			Dry..	.....	31.15	56.20	12.65	.59	.....
	557–D...	Coke	Wet..	.03	2.26	78.54	19.17	.57	.1222
			Dry..	.....	2.26	78.56	19.18	.57	.....
267	561–D...	Coal	Wet..	3.52	31.98	53.05	11.45	.50	.....
			Dry..	.....	33.16	54.98	11.86	.52	.....
	588–D...	Coke	Wet..	.16	.88	82.31	16.65	.55	.1327
			Dry..	.....	.88	82.44	16.68	.55	.....

DENVER No. 19.

Coking tests.

	Test—				
	269 (19B).	270 (19B).	272 (19A).	273 (19A).	274 (19C).
Date	9,30,08	10,3,08	10,5,08	10,7,08	10,12,08
Duration, hours	24	36	42	41	33
Size:					
As shipped	r. o. m. No. 5	r. o. m. No. 5	r. o. m. No. 5	r. o. m. No. 5	r. o. m. No. 4
As used	[a] w., f. c.	[a] w., f. c.	w., f. c.	w., f. c.	w., f. c.
Coal charged:					
Wet, pounds	12,700	6,330	8,850	8,020	6,950
Dry, do	12,216	5,984	7,582	7,189	6,018
Coke produced:					
Wet, do	None.	None.	3,450	None.	None.
Wet, per cent	.....	.....	38.98	.....	.....
Dry, pounds	.....	.....	3,448	.....	.....
Dry, per cent	.....	.....	45.48	.....	.....
Breeze produced:					
Wet, pounds	.....	.....	1,050	.....	.....
Wet, per cent	.....	.....	11.87	.....	.....
Dry, pounds	.....	.....	1,049	.....	.....
Dry, per cent	.....	.....	13.84	.....	.....
Total yield:					
Wet, do	.....	.....	50.85	.....	.....
Dry, do	.....	.....	59.32	.....	.....
Physical properties of coke:					
Specific gravity—					
Apparent	.....	.....	1.06	.....	.....
Real	.....	.....	1.84	.....	.....
Volume—					
Coke, per cent	.....	.....	58.00	.....	.....
Cells, do	.....	.....	42.00	.....	.....
Weight per cubic foot—					
Wet, pounds	.....	.....	92.28	.....	.....
Dry, do	.....	.....	66.07	.....	.....

[a] Washed at mine.

Remarks.—Tests 269, 270, 273, and 274 produced no coke.

Test 272: The upper 3 inches of the charge did not stick together or show signs of coking. The lower 12 inches fused and formed very soft coke, with slight cohesion and scarcely any definite cell structure. Breakage of charge drawn, very poor—large percentage went to breeze on dumping from barrows. No drop test was made.

Chemical analyses.

Test No.	Laboratory No.		Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
269 (19B)	584-D...	Coal ..... Wet..	3.81	36.60	41.45	18.14	0.71	.....
		Coal ..... Dry..	.....	38.05	43.09	18.86	.74	.....
270 (19B)	587-D...	Coal ..... Wet..	5.47	35.30	41.44	17.79	.67	.....
		Coal ..... Dry..	.....	37.35	43.83	18.82	.71	.....
272 (19A)	591-D...	Coal ..... Wet..	14.33	30.61	40.24	14.82	.71	.....
		Coal ..... Dry..	.....	35.72	46.98	17.30	.83	.....
	592-D...	Coke..... Wet..	.05	2.78	76.42	20.75	.53	0.0550
		Coke..... Dry..	.....	2.78	76.46	20.76	.53	.....
273 (19A)	602-D...	Coal ..... Wet..	10.36	33.20	41.98	14.46	.82	.....
		Coal ..... Dry..	.....	37.03	46.84	16.13	.92	.....
274 (19C)	629-D...	Coal ..... Wet..	13.41	31.66	41.59	13.34	.61	.....
		Coal ..... Dry..	.....	36.56	48.04	15.40	.70	.....

DENVER No. 20.

Coking tests.

	Test—			
	287.	288.	289.	290.
Date	11,7.08	11,9,08	11,10,08	11,12,08
Duration.....hours..	38	44	72	44
Size:				
As shipped	r. o. m.	r. o. m.	r. o. m.	r. o. m.
As used	w., n. c.	w., f. c.	w., f. c.	w., f. c.
Coal charged:				
Wet.....pounds..	10,580	12,400	16,300	12,300
Dry.....do....	9,607	11,463	15,139	11,643
Coke produced:				
Wet.....do....	6,654	7,950	10,350	8,100
.....per cent..	62.89	64.11	63.50	65.85
Dry.....pounds...	6,550	7,938	10,305	8,098
.....per cent..	68.18	69.25	68.07	69.55
Breeze produced:				
Wet.....pounds...	277	304	378	295
.....per cent..	2.62	2.45	2.32	2.40
Dry.....pounds...	273	304	376	295
.....per cent..	2.84	2.65	2.48	2.53
Total yield:				
Wet.....do....	65.51	66.56	65.82	68.25
Dry.....do....	71.02	71.90	70.55	72.08
Physical properties of coke:				
Specific gravity—				
Apparent	1.03	1.10	1.09	1.04
Real	1.95	1.99	1.97	1.97
Volume—				
Coke.....per cent..	53.00	55.00	55.00	53.00
Cells.....do....	47.00	45.00	45.00	47.00
Weight per cubic foot—				
Wet.....pounds..	92.54	96.55	95.75	94.11
Dry.....do....	63.25	68.47	67.67	64.81
6-foot drop test over 2-inch mesh—				
1.....per cent..	97.50	98.50	97.00	98.00
2.....do....	95.00	98.00	94.00	96.00
3.....do....	93.50	96.50	92.50	93.50
4.....do....	91.00	95.00	88.00	91.00
5.....do....	93.50	97.50	93.00	92.50

Remarks.—Tests 287 and 288: Light gray and silvery. Breakage good. Cell structure a little small. Good, strong, heavy coke.

Tests 289 and 290: Light gray and silvery, large deposit of carbon. Breakage good; long, large pieces. Cell structure small, dense. Metallic ring. Good, hard, strong, heavy coke.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
287	786–D...	Coal	Wet..	9.20	29.12	49.86	11.82	0.51	.....
			Dry..	.....	32.07	54.91	13.02	.56	.....
	790–D...	Coke	Wet..	1.57	2.03	78.11	18.29	.57	0.0460
			Dry..	.....	2.06	79.39	18.55	.58	.....
288	788–D...	Coal	Wet..	7.56	30.32	47.61	14.51	.56	.....
			Dry..	.....	32.79	51.51	15.70	.61	.....
	794–D...	Coke	Wet..	.15	.16	79.51	20.18	.60	.0477
			Dry..	.....	.16	79.63	20.21	.60	.....
289	791–D...	Coal	Wet..	7.12	29.12	50.94	12.82	.53	.....
			Dry..	.....	31.36	54.84	13.80	.57	.....
	799–D...	Coke	Wet..	.43	2.81	76.80	19.96	.55	.0579
			Dry..	.....	2.82	77.14	20.04	.55	.....
290	795–D...	Coal	Wet..	5.34	30.93	52.57	11.16	.53	.....
			Dry..	.....	32.68	55.52	11.80	.56	.....
	801–D...	Coke	Wet..	.03	.71	80.99	18.27	.44	.0481
			Dry..	.....	.71	81.02	18.27	.44	.....

DENVER No. 21.

Coking tests.

	Test—				
	277 (21A).	279 (21A).	278 (21B).	280 (21B).	281 (21B).
Date	10,22,08	10,24,08	10,23,08	10,26,08	10,27,08
Duration, hours	36	47	43	44	51
Size:					
As shipped	r. o. m.	r. o. m.	¾-in.	¾-in.	¾-in.
As used	r., f. c.	w., f. c.	r., f. c.	w., f. c.	w., f. c.
Coal charged:					
Wet, pounds	9,270	11,700	11,000	12,300	11,100
Dry, do	8,572	10,815	10,745	11,646	10,109
Coke produced:					
Wet, do	5,670	6,996	6,450	7,200	6,309
Wet, per cent	61.17	59.79	58.64	58.54	56.84
Dry, pounds	5,649	6,951	6,407	7,129	6,158
Dry, per cent	65.90	64.27	59.63	61.21	60.92
Breeze produced:					
Wet, pounds	342	320	315	300	283
Wet, per cent	3.69	2.74	2.86	2.44	2.55
Dry, pounds	341	318	313	297	276
Dry, per cent	3.98	2.94	2.91	2.55	2.73
Total yield:					
Wet, do	64.86	62.53	61.50	60.98	59.39
Dry, do	69.88	67.21	63.54	63.76	63.65
Physical properties of coke:					
Specific gravity—					
Apparent	0.96	0.92	0.97	0.89	0.89
Real	1.94	1.90	1.94	1.91	1.89
Volume—					
Coke, per cent	49.00	48.00	50.00	47.00	47.00
Cells, do	51.00	52.00	50.00	53.00	53.00
Weight per cubic foot—					
Wet, pounds	91.48	89.42	91.29	88.05	87.25
Dry, do	59.66	57.00	60.08	54.98	54.18
6-foot drop test over 2-inch mesh—					
1, per cent	91.00	94.50	93.00	91.00	92.50
2, do	83.50	82.00	83.50	84.50	87.00
3, do	77.00	77.00	80.00	79.00	80.00
4, do	71.00	70.50	73.00	73.50	74.50
5, do	73.00	71.50	70.50	75.00	75.50

Remarks.—Test 277: Light gray and silvery, large deposit of carbon. Breakage, fingered. Very brittle. Top cemented together with deposited carbon. Cell structure a little large. Metallic ring.

Test 279: Same as from raw coal (test 277), except ash and sulphur lower.

Test 278: Same as test 277; not so much deposited carbon.

Test 280: Light gray and silvery. Breakage, long, fine-fingered pieces. Cell structure large; small at top and increasing gradually almost to sponge at bottom. Metallic ring. Brittle.

Test 281: Light gray and silvery. Breakage long, thin, fine-fingered pieces. Brittle. Cell structure a little large, but good, no sponge; slow draft probably the cause. Metallic ring. Good coke.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
277 (21A)	692-D...	Coal	Wet	7.53	31.49	46.11	14.87	0.76	.....
			Dry	.....	34.06	49.86	16.08	.82	.....
	696-D...	Coke	Wet	.39	1.96	73.58	24.07	.53	0.1124
			Dry	.....	1.97	73.86	24.17	.53	.....
279 (21A)	695-D...	Coal	Wet	7.56	33.61	49.20	9.63	.68	.....
			Dry	.....	36.35	53.23	10.42	.74	.....
	697-D...	Coke	Wet	.64	1.30	81.03	17.03	.66	.1188
			Dry	.....	1.31	81.55	17.14	.66	.....
278 (21B)	694-D...	Coal	Wet	2.32	37.02	47.08	13.58	.60	.....
			Dry	.....	37.90	48.20	13.90	.61	.....
	699-D...	Coke	Wet	.67	.69	76.92	21.72	.38	.1137
			Dry	.....	.70	77.43	21.87	.38	.....
280 (21B)	698-D...	Coal	Wet	5.32	36.37	48.40	9.91	.63	.....
			Dry	.....	38.42	51.11	10.47	.67	.....
	702-D...	Coke	Wet	.99	2.42	70.42	26.17	.52	.1217
			Dry	.....	2.44	71.13	26.43	.53	.....
281 (21B)	700-D...	Coal	Wet	8.93	34.77	46.07	10.23	.56	.....
			Dry	.....	38.18	50.59	11.23	.62	.....
	704-D...	Coke	Wet	2.40	1.83	79.45	16.32	.57	.1208
			Dry	.....	1.88	81.40	16.72	.58	.....

DENVER No. 22.

Coking tests.

	Test—	
	275.	276.
Date	10,16,08	10,19,08
Duration, hours	45	34
Size:		
As shipped	r. o. m.	r. o. m.
As used	w., f. c.	w., n. c.
Coal charged:		
Wet, pounds	10,590	10,200
Dry, do	9,245	8,402
Coke produced:		
Wet, do	6,300	5,930
Wet, per cent	59.49	58.13
Dry, pounds	6,236	5,865
Dry, per cent	67.45	69.80
Breeze produced:		
Wet, pounds	417	275
Wet, per cent	3.94	2.70
Dry, pounds	413	272
Dry, per cent	4.47	3.24
Total yield:		
Wet, do	63.43	60.83
Dry, do	71.92	73.04
Physical properties of coke:		
Specific gravity—		
Apparent	1.28	1.13
Real	2.01	1.91
Volume—		
Coke, per cent	64.00	59.00
Cells, do	36.00	41.00
Weight per cubic foot—		
Wet, pounds	101.46	95.29
Dry, do	79.02	69.72
6-foot drop test over 2-inch mesh—		
1, per cent	98.00	97.00
2, do	97.00	94.00
3, do	96.00	89.50
4, do	94.50	86.00
5, do	94.50	89.50

Remarks.—Test 275: Dull gray color. Breakage, large, irregular chunks. Cell structure very small. Soft, dense, tough coke. High ash and sulphur.

Test 276: Dull gray color. Breakage, large, irregular chunks. Cell structure small, but not so dense as in test 275. Heavy, dense coke. Ash and sulphur reduced by washing, ash reduction particularly noticeable.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
275	654–D	Coal	Wet	12.70	21.04	39.84	26.42	3.64	.....
			Dry	.....	24.10	45.64	30.26	4.17	.....
	690–D	Coke	Wet	1.02	1.13	61.48	36.37	3.19	0.0328
			Dry	.....	1.14	62.12	36.74	3.22	.....
276	689–D	Coal	Wet	17.63	22.78	47.57	12.02	2.79	.....
			Dry	.....	27.65	57.76	14.59	3.39	.....
	691–D	Coke	Wet	1.10	.92	77.51	20.47	2.41	.0225
			Dry	.....	.93	78.38	20.69	2.44	.....

DENVER No. 23.

Coking tests.

	Test—				
	282.	283.	284.	285.	286.
Date	10,28,08	10,31,08	10,31,08	11,3,08	11,5,08
Duration, hours	42	61	67	73	43
Size:					
As shipped	r. o. m.	r. o. m.	r. o. m.	r. o. m.	r. o. m.
As used	w., f. c.	w., f. c.	w., f. c.	w., f. c.	w., n. c.
Coal charged:					
Wet, pounds	9,200	13,150	14,600	14,660	11,300
Dry, do	8,681	11,927	13,311	12,674	10,249
Coke produced:					
Wet, do	5,250	7,150	7,800	7,612	7,050
Wet, per cent	57.07	54.37	53.42	51.92	62.39
Dry, pounds	5,243	7,119	7,745	7,603	7,030
Dry, per cent	60.40	59.69	58.19	59.99	68.59
Breeze produced:					
Wet, pounds	208	295	325	300	278
Wet, per cent	2.26	2.24	2.23	2.05	2.46
Dry, pounds	208	294	323	300	277
Dry, per cent	2.40	2.47	2.43	2.37	2.70
Total yield:					
Wet, do	59.33	56.61	55.65	53.97	64.85
Dry, do	62.80	62.16	60.62	62.36	71.28
Physical properties of coke:					
Specific gravity—					
Apparent	0.85	0.82	0.87	0.88	0.90
Real	1.91	1.87	1.91	1.91	1.99
Volume—					
Coke, per cent	45.00	44.00	46.00	46.00	45.00
Cells, do	55.00	56.00	54.00	54.00	55.00
Weight per cubic foot—					
Wet, pounds	87.21	85.84	87.55	88.51	90.26
Dry, do	52.92	50.90	53.87	54.83	55.97
6-foot drop test over 2-inch mesh—					
1, per cent	97.00	97.00	96.50	97.50	97.00
2, do	94.50	94.50	94.00	94.00	95.00
3, do	92.00	92.00	91.50	91.50	93.50
4, do	89.50	89.50	90.00	89.50	92.00
5, do	93.00	94.00	93.00	92.50	93.00

Remarks.—Tests 282, 283, 284, 285: Light gray and silvery. Breakage somewhat cross-fractured, but pieces of good, large, uniform size. Cell structure a little large. Metallic ring. Low percentage of yield probably due to burning of coke at door. High sulphur.

Test 286: Light gray and silvery. Breakage somewhat cross-fractured, not so good as four preceding tests, but pieces still of good, large, uniform size. Cell structure

a little large. Breakage and cells, as well as higher percentage of breeze, probably due to not crushing. High sulphur. Percentage of sulphur too high for iron blast furnace purposes, but should give good results in any practice where sulphur is not detrimental. Larger yield of coke due to small, slow draft.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
282	703-D...	Coal	Wet..	5.64	36.51	51.23	6.62	3.10	.....
			Dry..	.....	38.69	54.29	7.02	3.29	.....
	728-D...	Coke	Wet..	.13	.69	87.65	11.53	2.56	0.0399
			Dry..	.....	.69	87.77	11.54	2.56	.....
283	705-D...	Coal	Wet..	9.30	34.86	50.19	5.65	2.81	.....
			Dry..	.....	38.44	55.33	6.23	3.10	.....
	730-D...	Coke	Wet..	.44	.62	88.61	10.33	2.59	.0346
			Dry..	.....	.62	89.00	10.38	2.60	.....
284	727-D...	Coal	Wet..	8.83	34.32	50.96	5.89	3.13	.....
			Dry..	.....	37.65	55.89	6.46	3.43	.....
	731-D...	Coke	Wet..	.71	.15	88.68	10.46	2.75	.0327
			Dry..	.....	.15	89.32	10.53	2.77	.....
285	729-D...	Coal	Wet..	13.55	32.27	45.78	8.40	3.59	.....
			Dry..	.....	37.33	52.95	9.72	4.15	.....
	736-D...	Coke	Wet..	.12	2.85	82.80	14.23	3.44	.0380
			Dry..	.....	2.85	82.90	14.25	3.44	.....
286	732-D...	Coal	Wet..	9.30	34.33	49.18	7.19	3.50	.....
			Dry..	.....	37.85	54.22	7.93	3.86	.....
	789-D...	Coke	Wet..	.28	.12	87.38	12.22	2.67	.0354
			Dry..	.....	.12	87.63	12.25	2.68	.....

DENVER No. 25.

Coking tests.

	Test—			
	291.	292.	295.	296.
Date	11,14,08	11,16,08	11,23,08	11,27,08
Duration ....hours..	40	45	62	87
Size:				
As shipped	1-in. scr.	1-in scr.	1-in. scr.	1-in. scr.
As used	r., f. c.	w., f. c.	w., f. c.	w., f. c.
Coal charged:				
Wet....pounds..	10,300	12,690	13,430	14,850
Dry....do....	9,897	11,860	12,467	13,600
Coke produced:				
Wet {....do....	5,925	7,538	7,870	8,436
{per cent..	57.52	59.40	58.60	56.81
Dry {pounds...	5,791	7,518	7,776	8,353
{per cent..	58.51	63.39	62.37	61.42
Breeze produced:				
Wet {pounds...	525	683	600	684
{per cent..	5.10	5.38	4.47	4.61
Dry {pounds...	513	681	593	677
{per cent..	5.18	5.74	4.76	4.98
Total yield:				
Wet....do....	62.62	64.78	63.07	61.42
Dry....do....	63.69	69.13	67.13	66.40
Physical properties of coke:				
Specific gravity—				
Apparent	1.01	0.98	0.97	1.01
Real	1.84	1.86	1.84	1.84
Volume—				
Coke....per cent..	55.00	53.00	53.00	55.00
Cells....do....	45.00	47.00	47.00	45.00
Weight per cubic foot—				
Wet....pounds..	89.65	90.26	89.08	90.45
Dry....do....	61.57	60.96	59.87	62.37
6-foot drop test over 2-inch mesh—				
1....per cent..	97.50	94.50	97.00	94.50
2....do....	95.00	88.00	91.50	89.50
3....do....	92.50	81.00	86.00	84.00
4....do....	91.00	78.00	82.00	79.50
5....do....	93.50	81.50	88.00	83.00

Remarks.—Test 291: Light gray, some little silvery deposit of carbon. Breakage, good, long pieces, somewhat fingered. Cell structure small.

Test 292: Light gray, some little silvery deposit of carbon. Breakage, two distinct layers, practically dividing charge in two parts, drawn in 9-inch chunks similar to by-product coke. Cell structure small. Metallic ring. Very brittle. Ash reduced by washing.

Test 295: Light gray and silvery. Breakage same as in test 292, except that chunks were 12 and 6 inches in layers, pieces from each layer nearly uniform in size and breaking but little after drawn. Cell structure very small and dense. Good, heavy, dense coke, but brittle.

Test 296: Light gray and silvery. Two layers of 16 and 8 inches, the upper 16 inches somewhat fingered, the lower 8 inches in 8-inch cubes of uniform size. Cell structure very small and dense. Good, heavy, dense, coke, but brittle.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
291	798–D...	Coal	Wet..	3.91	33.85	47.28	14.96	0.75	.....
			Dry..	.....	35.24	49.19	15.57	.78	.....
	802–D...	Coke	Wet..	2.26	1.79	77.40	18.55	.59	0.0149
			Dry..	.....	1.83	79.19	18.98	.60	.....
292	800–D...	Coal	Wet..	6.54	36.51	48.31	8.64	.70	.....
			Dry..	.....	39.06	51.70	9.24	.75	.....
	806–D...	Coke	Wet..	.27	.34	84.12	15.27	.47	.0121
			Dry..	.....	.34	84.36	15.30	.47	.....
295	837–D...	Coal	Wet..	7.17	34.97	48.62	9.24	.66	.....
			Dry..	.....	37.68	52.37	9.95	.71	.....
	842–D...	Coke	Wet..	1.20	1.94	81.76	15.10	.49	.0111
			Dry..	.....	1.96	82.75	15.29	.50	.....
296	841–D...	Coal	Wet..	8.42	33.18	48.37	10.03	.69	.....
			Dry..	.....	36.23	52.82	10.95	.75	.....
	856–D...	Coke	Wet..	.98	1.14	82.22	15.63	.65	.0153
			Dry..	.....	1.15	83.04	15.81	.66	.....

DENVER No. 26.

Coking tests.

	Test 293.
Date	11,18,08
Duration, hours	48
Size:	
As shipped	r. o. m.
As used	r., f. c.
Coal charged (wet), pounds	9,300
Coke produced	None.

Remarks.—Test 293: No coke produced. All volatile apparently expelled. Drawn from oven in same condition as charged, each separate piece coming out in size and shape as charged. No evidence of fusion or coking. Heavy clinker over whole top of charge. This is subbituminous coal.

Chemical analyses.

Test No.	Laboratory No.		Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
293	803-D...	Coal.....Wet..	19.28	34.61	41.41	4.70	0.39	.....
		Dry..	.....	42.87	51.30	5.83	.48	.....

DENVER No. 27.

Coking tests.

	Test—			
	297.	300.	301.	302.
Date	11,28,08	12,5,08	12,8,08	12,7,08
Duration.....hours..	56	57	65	48
Size:				
As shipped	r. o. m.	r. o. m.	r. o m.	r. o. m.
As used	r., f. c.	r., f. c.	w., f. c.	w., f. c.
Coal charged:				
Wet.....pounds..	10,650	13,080	14,400	11,100
Dry.....do....	10,315	12,668	13,668	10,645
Coke produced:				
Wet.....do....	7,200	8,700	9,150	7,350
Wet.....per cent..	67.61	66.51	63.54	66.22
Dry.....pounds...	7,184	8,661	9,125	7,327
Dry.....per cent..	69.65	68.37	66.76	68.83
Breeze produced:				
Wet.....pounds...	274	300	373	219
Wet.....per cent..	2.57	2.29	2.59	1.97
Dry.....pounds...	273	299	372	218
Dry.....per cent..	2.65	2.36	2.72	2.05
Total yield:				
Wet.....do....	70.18	68.80	66.13	68.19
Dry.....do....	72.30	70.73	69.48	70.88
Physical properties of coke:				
Specific gravity—				
Apparent	0.93	0.93	0.88	0.85
Real	2.04	2.10	2.09	2.11
Volume—				
Coke.....per cent..	46.00	42.00	42.00	40.00
Cells.....do....	54.00	58.00	58.00	60.00
Weight per cubic foot—				
Wet.....pounds..	91.55	93.88	90.91	90.26
Dry.....do....	57.87	57.72	54.75	52.84
6-foot drop test over 2-inch mesh—				
1.....per cent..	97.50	96.50	97.50	97.50
2.....do....	94.00	94.00	95.50	95.00
3.....do....	91.00	92.00	93.00	92.50
4.....do....	87.50	87.00	91.50	89.50
5.....do....	90.50	92.50	94.00	93.50

Remarks.—Test 297: Light gray, some little silvery deposit of carbon and 2-inch black butts. Breakage badly cross fractured. Cell structure large. Metallic ring. Washing, larger charge, and slow draft probably would improve quality.

Test 300: Light gray and silvery, butts removed. Breakage badly cross fractured, but good. Cell structure large. Metallic ring. One inch less draft.

Test 301: Light gray and silvery. Breakage badly cross fractured, but pieces of good, large, uniform size. Cell structure large. Metallic ring.

Test 302: Light gray, some little silvery deposit of carbon. Breakage, badly cross fractured, but pieces of good, large, uniform size. Cell structure large. Metallic ring.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
297	851-D	Coal	Wet	3.15	33.39	49.65	13.81	0.66	.....
			Dry	.....	34.47	51.27	14.26	.68	.....
	854-D	Coke	Wet	.22	.73	79.96	19.09	.55	0.0113
			Dry	.....	.73	80.13	19.14	.55	.....
300	858-D	Coal	Wet	3.15	34.42	47.71	14.72	.58	.....
			Dry	.....	35.55	49.25	15.20	.60	.....
	885-D	Coke	Wet	.45	1.11	78.27	20.17	.49	.0105
			Dry	.....	1.12	78.62	20.26	.49	.....
301	886-D	Coal	Wet	5.08	32.00	52.78	10.14	.59	.....
			Dry	.....	33.71	55.61	10.68	.62	.....
	896-D	Coke	Wet	.27	.56	84.37	14.80	.54	.0114
			Dry	.....	.56	84.60	14.84	.54	.....
302	887-D	Coal	Wet	4.10	31.66	54.16	10.08	.61	.....
			Dry	.....	33.01	56.48	10.51	.64	.....
	900-D	Coke	Wet	.31	.49	85.01	14.19	.49	.0109
			Dry	.....	.50	85.27	14.23	.50	.....

DENVER No. 28.

Coking tests.

	Test—		
	298.	303.	305.
Date	11,28,08	12,9,08	12,11,08
Duration, hours	24	39	36
Size:			
As shipped	r. o. m.	r. o. m.	r. o. m.
As used	r., f. c.	w., f. c.	w., n. c.
Coal charged:			
Wet, pounds	12,930	10,510	6,510
Dry, do	12,049	9,540	5,959
Coke produced	None.	None.	None.

Remarks.—Test 298: No coke produced. Burned for twenty-four hours with very hot flame. Did not ash.

Test 303: No coke produced. All volatile expelled. Drawn from oven in same size as charged. No evidence of fusion or coherence.

Test 305: This was an attempt to produce coke from coal not crushed, with the oven heated up with a charge of red-hot coke at the door. The product showed some signs of coking. High heat of by-product ovens might give better results.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.
298	853-D	Coal	Wet	6.81	35.28	46.50	11.41	0.60
			Dry	.....	37.86	49.89	12.25	.64
303	893-D	Coal	Wet	9.23	34.06	48.79	7.92	.55
			Dry	.....	37.52	53.75	8.73	.60
305	892-D	Coal	Wet	8.46	32.01	50.83	8.70	.57
			Dry	.....	34.96	55.54	9.50	.62

DENVER No. 29.

Coking tests.

	Test—	
	299.	306.
Date	12,2,08	12,15,08
Duration, hours	77	82
Size:		
As shipped	r. o. m.	r. o. m.
As used	r., f. c.	w., f. c.
Coal charged:		
Wet, pounds	13,000	13,450
Dry, do	12,757	12,815
Coke produced:		
Wet, do	8,899	9,150
Wet, per cent	68.45	68.03
Dry, pounds	8,853	9,116
Dry, per cent	69.40	71.13
Breeze produced:		
Wet, pounds	258	218
Wet, per cent	1.99	1.62
Dry, pounds	257	217
Dry, per cent	2.01	1.69
Total yield:		
Wet, do	70.44	69.65
Dry, do	71.41	72.82
Physical properties of coke:		
Specific gravity—		
Apparent	0.80	0.79
Real	1.99	2.06
Volume—		
Coke, per cent	40.00	38.00
Cells, do	60.00	62.00
Weight per cubic foot—		
Wet, pounds	87.06	87.74
Dry, do	49.64	49.07
6-foot drop test over 2-inch mesh—		
1, per cent	99.00	99.00
2, do	98.00	97.50
3, do	96.50	97.00
4, do	95.50	96.00
5, do	97.00	97.50

Remarks.—Test 299: Dull gray color, some little deposit of carbon. Breakage, very badly cross fractured, but pieces of good size. Not brittle, very little breaking down to breeze. Cell structure very small, dense. Percentage of cells by volume very large, but cells very small.

Test 306: Same as test 299. Ash reduced by washing.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
299	855-D	Coal	Wet	1.87	22.89	67.08	8.16	0.70	.....
			Dry	.....	23.32	68.36	8.32	.71	.....
	881-D	Coke	Wet	.52	1.41	87.77	10.30	.48	0.0404
			Dry	.....	1.42	88.23	10.35	.48	.....
306	897-D	Coal	Wet	4.72	22.24	66.85	6.19	.50	.....
			Dry	.....	23.34	70.17	6.49	.52	.....
	917-D	Coke	Wet	.37	.28	91.33	8.02	.58	.0425
			Dry	.....	.28	91.67	8.05	.58	.....

DENVER No. 30.

Coking tests.

	Test 304.
Date	12,12,08
Duration, hours	67
Size:	
As shipped	r. o. m.
As used	w., f. c.
Coal charged:	
Wet, pounds	13,110
Dry, do	12,313
Coke produced:	
Wet, do	8,850
Wet, per cent	67.51
Dry, pounds	8,800
Dry, per cent	71.47
Breeze produced:	
Wet, pounds	313
Wet, per cent	2.38
Dry, pounds	311
Dry, per cent	2.52
Total yield:	
Wet, do	69.89
Dry, do	73.99
Physical properties of coke:	
Specific gravity—	
Apparent	0.87
Real	2.08
Volume—	
Coke, per cent	42.00
Cells, do	58.00
Weight per cubic foot—	
Wet, pounds	90.11
Dry, do	53.95
6-foot drop test over 2-inch mesh—	
1, per cent	98.50
2, do	97.00
3, do	94.50
4, do	93.00
5, do	96.50

Remarks.—Test 304: Dull gray color, some little deposit of carbon. Breakage, very badly cross fractured, but pieces of good uniform size and not brittle. Cell structure very small, dense. High yield of coke and low percentage of breeze. Drop tests show very small breakage.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
304	891-D	Coal	Wet	6.08	23.06	62.12	8.74	0.43	.....
			Dry	.....	24.55	66.14	9.31	.46	.....
	899-D	Coke	Wet	.57	1.96	85.82	11.65	.48	0.0349
			Dry	.....	1.97	86.31	11.72	.48	.....

DENVER No. 31.

Coking tests.

	Test—		
	311.	312.	313.
Date	12,28,8	12,31,8	12,30,8
Duration, hours	37	64	37
Size:			
As shipped	r. o. m.	r. o. m.	r. o. m.
As used	r., f. c.	w., f. c.	w., f. c.
Coal charged:			
Wet, pounds	10,400	13,200	9,000
Dry, do	10,097	12,726	8,580
Coke produced:			
Wet, do	6,150	8,100	5,100
Wet, per cent	59.13	61.36	56.67
Dry, pounds	6,071	8,055	4,967
Dry, per cent	60.13	63.30	57.89
Breeze produced:			
Wet, pounds	450	332	217
Wet, per cent	4.33	2.52	2.41
Dry, pounds	444	330	211
Dry, per cent	4.40	2.59	2.46
Total yield:			
Wet, do	63.46	63.88	59.08
Dry, do	64.53	65.89	60.35
Physical properties of coke:			
Specific gravity—			
Apparent	0.97	0.97	0.93
Real	2.16	2.14	2.21
Volume—			
Coke, per cent	45.00	45.00	42.00
Cells, do	55.00	55.00	58.00
Weight per cubic foot—			
Wet, pounds	94.03	94.45	92.62
Dry, do	59.74	60.16	56.46
6-foot drop test over 2-inch mesh—			
1, per cent	92.50	94.50	96.00
2, do	82.00	89.00	89.50
3, do	76.00	84.00	84.00
4, do	66.00	80.50	80.50
5, do	87.50	87.00	86.50

Remarks.—Test 311: Dull gray color. Breakage, badly cross fractured, fine fingered, breaking badly. Cell structure little large. Soft coke.

Test 312: Gray color, some little silvery deposit of carbon. Breakage, badly cross fractured, fine fingered, and brittle. Cell structure a little large. Metallic ring. Improvement over raw charge, as well as small washed charge.

Test 313: Dull gray color, some little carbon. Breakage, very badly cross fractured. Fingered, soft, and brittle. Cell structure a little large, but better than that from raw charge. Ash reduced by washing.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
311	969–D...	Coal	Wet	2.91	36.78	46.92	13.39	0.90	.....
			Dry	.....	37.88	48.33	13.79	.93	.....
	976–D...	Coke	Wet	1.29	1.61	80.01	17.09	.73	0.0113
			Dry	.....	1.63	81.06	17.31	.74	.....
312	974–D...	Coal	Wet	3.59	38.97	47.43	10.01	.81	.....
			Dry	.....	40.42	49.20	10.38	.84	.....
	985–D...	Coke	Wet	.55	.60	83.29	15.56	.59	.0123
			Dry	.....	.60	83.75	15.65	.59	.....
313	975–D...	Coal	Wet	4.67	39.50	46.49	9.34	.76	.....
			Dry	.....	41.44	48.76	9.80	.80	.....
	978–D...	Coke	Wet	2.60	1.55	81.76	14.09	.59	.0114
			Dry	.....	1.59	83.95	14.46	.61	.....

DENVER No. 32.

Coking tests.

	Test—		
	308.	309.	310.
Date	12,24,8	12,26,8	12,28,8
Duration, hours	41	36	45
Size:			
As shipped	r. o. m.	r. o. m.	r. o. m.
As used	r., f. c.	w., n. c.	w., f. c.
Coal charged:			
Wet, pounds	10,080	9,470	8,100
Dry, do	9,270	8,584	7,291
Coke produced	None.	None.	None.

Remarks.—Test 308: No coke produced. No evidence of fusion or coking when the oven was drawn after forty hours.

Tests 309 and 310: No coke produced. Volatile was practically all expelled, but coal was drawn from the oven the same size as charged. No evidence of fusion or coking. Charges ashed down about 1 inch over the whole oven.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.
308	967–D	Coal	Wet	8.04	36.93	45.61	9.42	1.63
			Dry		40.16	49.60	10.24	1.77
309	968–D	Coal	Wet	9.36	36.97	45.90	7.77	1.40
			Dry		40.79	50.64	8.57	1.54
310	970–D	Coal	Wet	9.99	36.84	46.17	7.00	1.38
			Dry		40.93	51.29	7.78	1.53

DENVER No. 33.

Coking tests.

	Test—	
	314.	315.
Date	12,31,8	1,2,9
Duration, hours	28	31
Size:		
As shipped	r. o. m.	r. o. m.
As used	r., f. c.	w., f. c.
Coal charged:		
Wet, pounds	10,600	10,100
Dry, do	9,661	9,204
Coke produced	None.	None.

Remarks.—Tests 314 and 315: Burned for 28 and 31 hours, respectively. No evidence of fusion or coking.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.
314	977–D	Coal	Wet	8.86	37.96	48.56	4.62	1.00
			Dry		41.65	53.28	5.07	1.10
315	986–D	Coal	Wet	8.87	38.62	48.69	3.82	.82
			Dry		42.38	53.43	4.19	.90

DENVER Nos. 19A AND 20 MIXED IN EQUAL PORTIONS.

Coking tests.

	Test 294.
Date	11,19,08
Duration, hours	27
Size:	
As shipped	r. o. m.
As used	w., f. c.
Coal charged:	
Wet, pounds	8,450
Dry, do	8,002
Coke produced:	
Wet, do	4,886
Wet, per cent	57.82
Dry, pounds	4,863
Dry, per cent	60.77
Breeze produced:	
Wet, pounds	475
Wet, per cent	5.62
Dry, pounds	473
Dry, per cent	5.91
Total yield:	
Wet, do	63.44
Dry, do	66.68
Physical properties of coke:	
Specific gravity—	
Apparent	1.05
Real	1.94
Volume—	
Coke, per cent	54.00
Cells, do	46.00
Weight per cubic foot—	
Wet, pounds	93.88
Dry, do	65.19
6-foot drop test over 2-inch mesh—	
1, per cent	98.50
2, do	97.00
3, do	94.50
4, do	92.50
5, do	94.00

Remarks.—Test 294: Dull gray color. Breakage, good. Cell structure very small, dense. Poor, soft, punky coke. Addition of noncoking (19A) to good coking (20) coal changed otherwise good coke into one of poor quality.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
294	807–D	Coal	Wet	5.30	33.49	45.78	15.43	0.62	.....
			Dry	.....	35.36	48.35	16.29	.66	.....
	830–D	Coke	Wet	.48	.91	74.81	23.80	.55	0.0942
			Dry	.....	.91	75.17	23.92	.55	.....

DENVER Nos. 29 AND 30.

Coking tests.

	Test 307.
Date	12,16,8
Duration, hours	75
Size:	
As shipped	r. o. m.
As used	w., f. c.
Coal charged:	
Wet, pounds	13,650
Dry, do	13,096
Coke produced:	
Wet, do	9,150
Wet, per cent	67.03
Dry, pounds	9,013
Dry, per cent	68.82
Breeze produced:	
Wet, pounds	226
Wet, per cent	1.66
Dry, pounds	223
Dry, per cent	1.70
Total yield:	
Wet, do	68.69
Dry, do	70.52
Physical properties of coke:	
Specific gravity—	
Apparent	0.84
Real	2.11
Volume—	
Coke, per cent	40.00
Cells, do	60.00
Weight per cubic foot—	
Wet, pounds	89.00
Dry, do	51.59
6-foot drop test over 2-inch mesh—	
1, per cent	98.00
2, do	97.50
3, do	96.50
4, do	95.50
5, do	97.50

Remarks.—Test 307: These two coals were from the same bed, but only the upper coal (Denver No. 29) is used (raw) for coking. The object of this test was to show the possibilities of mixing and washing and then coking. The result warrants use of these coals if washed. Coke produced of dull gray color, very badly cross fractured, but of uniform size. Metallic ring. Very small cell structure, dense. Noticeable for small percentage of breeze produced and high yield of coke. Results practically the same as for the separate coals, tests 306 and 304.

Chemical analyses.

Test No.	Laboratory No.			Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Phosphorus.
307	898-D	Coal	Wet	4.06	22.82	65.47	7.65	0.46	.....
			Dry	.....	23.79	68.23	7.98	.48	.....
	918-D	Coke	Wet	1.50	1.26	87.50	9.74	.61	0.0358
			Dry	.....	1.28	88.83	9.89	.62	.....

NOTES ON TESTS AND CONCLUSIONS.

Denver No. 15, from Illinois, was tested with a view of producing metallurgical coke from coal from a field that had shown promise in previous tests at the St. Louis plant. The coal from a newly opened mine, not available during former tests, demonstrated by actual test in a copper smelter that good commercial metallurgical coke can be produced from Illinois coal in beehive ovens.

Denver No. 23, from the Weir-Pittsburg seam in Kansas, was tested to show the possibility of producing coke for zinc smelting, one of the State's large industries, for which coke is at present being imported from other States. The results show that coke of good quality, with low ash but high sulphur content, can be produced from some Kansas coal. The high sulphur of this coal, 5.38 per cent, is reduced 42 per cent by washing, and there is a further reduction of practically 18 per cent in conversion of coal to coke. The resultant sulphur, 2.56 per cent, though still high, is no detriment in zinc smelting.

Denver No. 19A, with addition of 50 per cent coking coal, produced soft, poor coke. The addition of noncoking coal to good coking coal changed the product from good coke to one of poor quality.

Denver No. 26 is subbituminous and possesses no coking qualities.

Denver Nos. 29 and 30 are from the same mine, the upper portion (29) being mined and used for manufacture of coke and the lower portion (30) being left in the mine. These two coals were mixed in equal portions, washed, and the resulting washed coal coked, producing about the same grade of coke as that from the separate portions. The results seemingly show that the whole seam of coal is available for the production of coke.

Denver No. 32 showed no sign of fusion or coking in the ovens, though commercial laboratories had reported it as coking coal.

The loss of sulphur in the 56 tests that produced coke averages 47.71 per cent, the lowest being 8.70 per cent for Denver Nos. 29 and 30 (test 307) and the highest 66.20 per cent for Denver No. 19A (test 272).

PUBLICATIONS ON FUEL TESTING.

The following publications, except those to which a price is affixed, can be obtained free by applying to the Director of the Bureau of Mines, Washington, D. C. The priced publications can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C.

PUBLICATIONS OF THE BUREAU OF MINES.

BULLETIN 1. The volatile matter of coal, by H. C. Porter and F. K. Ovitz. 1910. 56 pp., 1 pl.

BULLETIN 2. North Dakota lignite as a fuel for power-plant boilers, by D. T. Randall and Henry Kreisinger. 1910. 42 pp., 1 pl.

BULLETIN 3. The coke industry of the United States as related to the foundry, by Richard Moldenke. 1910. 32 pp.

BULLETIN 4. Features of producer-gas power-plant development in Europe, by R. H. Fernald. 1910. 32 pp., 7 pls.

PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY.

[Transferred to the Bureau of Mines.]

BULLETIN 261. Preliminary report on the operations of the coal-testing plant of the United States Geological Survey at the Louisiana Purchase Exposition, in St. Louis, Mo., 1904; E. W. Parker, J. A. Holmes, M. R. Campbell, committee in charge. 1905. 172 pp. 10 cents.

PROFESSIONAL PAPER 48. Report on the operations of the coal-testing plant of the United States Geological Survey at the Louisiana Purchase Exposition, St. Louis, Mo., 1904; E. W. Parker, J. A. Holmes, M. R. Campbell, committee in charge. 1906. In three parts. 1492 pp., 13 pls. $1.50.

BULLETIN 290. Preliminary report on the operations of the fuel-testing plant of the United States Geological Survey at St. Louis, Mo., 1905, by J. A. Holmes. 1906. 240 pp. 20 cents.

BULLETIN 323. Experimental work conducted in the chemical laboratory of the United States fuel-testing plant at St. Louis, Mo., January 1, 1905, to July 31, 1906, by N. W. Lord. 1907. 49 pp. 10 cents.

BULLETIN 325. A study of four hundred steaming tests made at the fuel-testing plant, St. Louis, Mo., 1904, 1905, and 1906, by L. P. Breckenridge. 1907. 196 pp. 20 cents.

BULLETIN 332. Report of the United States fuel-testing plant at St. Louis, Mo., January 1, 1906, to June 30, 1907; J. A. Holmes, in charge. 1908. 299 pp. 25 cents.

BULLETIN 334. The burning of coal without smoke in boiler plants; a preliminary report, by D. T. Randall. 1908. 26 pp. 5 cents. (See Bull. 373.)

BULLETIN 336. Washing and coking tests of coal and cupola tests of coke, by Richard Moldenke, A. W. Belden, and G. R. Delamater. 1908. 76 pp. 10 cents.

BULLETIN 339. The purchase of coal under government and commercial specifications on the basis of its heating value, with analyses of coal delivered under government contracts, by D. T. Randall. 1908. 27 pp. 5 cents. (See Bull. 428.)

BULLETIN 343. Binders for coal briquets, by J. E. Mills. 1908. 56 pp.

BULLETIN 362. Mine sampling and chemical analyses of coals tested at the United States fuel-testing plant, Norfolk, Va., in 1907, by J. S. Burrows. 1908. 23 pp. 5 cents.

BULLETIN 363. Comparative tests of run-of-mine and briquetted coal on locomotives, including torpedo-boat tests and some foreign specifications for briquetted fuel, by W. F. M. Goss. 1908. 57 pp., 4 pls.

BULLETIN 366. Tests of coal and briquets as fuel for house-heating boilers, by D. T. Randall. 1908. 44 pp., 3 pls.

BULLETIN 367. Significance of drafts in steam-boiler practice, by W. T. Ray and Henry Kreisinger. 1909. 61 pp.

BULLETIN 368. Washing and coking tests of coal at Denver, Colo., by A. W. Belden, G. R. Delamater, and J. W. Groves. 1909. 54 pp., 2 pls.

BULLETIN 373. The smokeless combustion of coal in boiler plants, by D. T. Randall and H. W. Weeks. 1909. 188 pp. 20 cents.

BULLETIN 378. The purchase of coal under Government specifications, by J. S. Burrows. 1909. 44 pp. 10 cents. (See Bull. 428.)

BULLETIN 382. The effect of oxygen in coal, by David White. 1909. 78 pp., 3 pls.

BULLETIN 385. Briquetting tests at the United States fuel-testing plant, Norfolk, Va., 1907–8, by C. L. Wright. 1909. 41 pp., 9 pls.

BULLETIN 392. Commercial deductions from comparisons of gasoline and alcohol tests on internal-combustion engines, by R. M. Strong. 1909. 38 pp.

BULLETIN 393. Incidental problems in gas-producer tests, by R. H. Fernald, C. D. Smith, J. K. Clement, and H. A. Grine. 1909. 29 pp.

BULLETIN 402. The utilization of fuel in locomotive practice, by W. F. M. Goss. 1909. 28 pp.

BULLETIN 403. Comparative tests of run-of-mine and briquetted coal on the torpedo boad *Biddle*, by Walter T. Ray and Henry Kreisinger. 1909. 49 pp.

BULLETIN 412. Tests of run-of-mine and briquetted coal in a locomotive boiler, by Walter T. Ray and Henry Kreisinger. 1909. 32 pp.

BULLETIN 416. Recent development of the producer-gas power plant in the United States, by R. H. Fernald. 1909. 82 pp., 2 pls. 15 cents.

BULLETIN 428. The purchase of coal by the Government under specifications, with analyses of coal delivered for the fiscal year 1908–9, by G. S. Pope. 80 pp. 10 cents.

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